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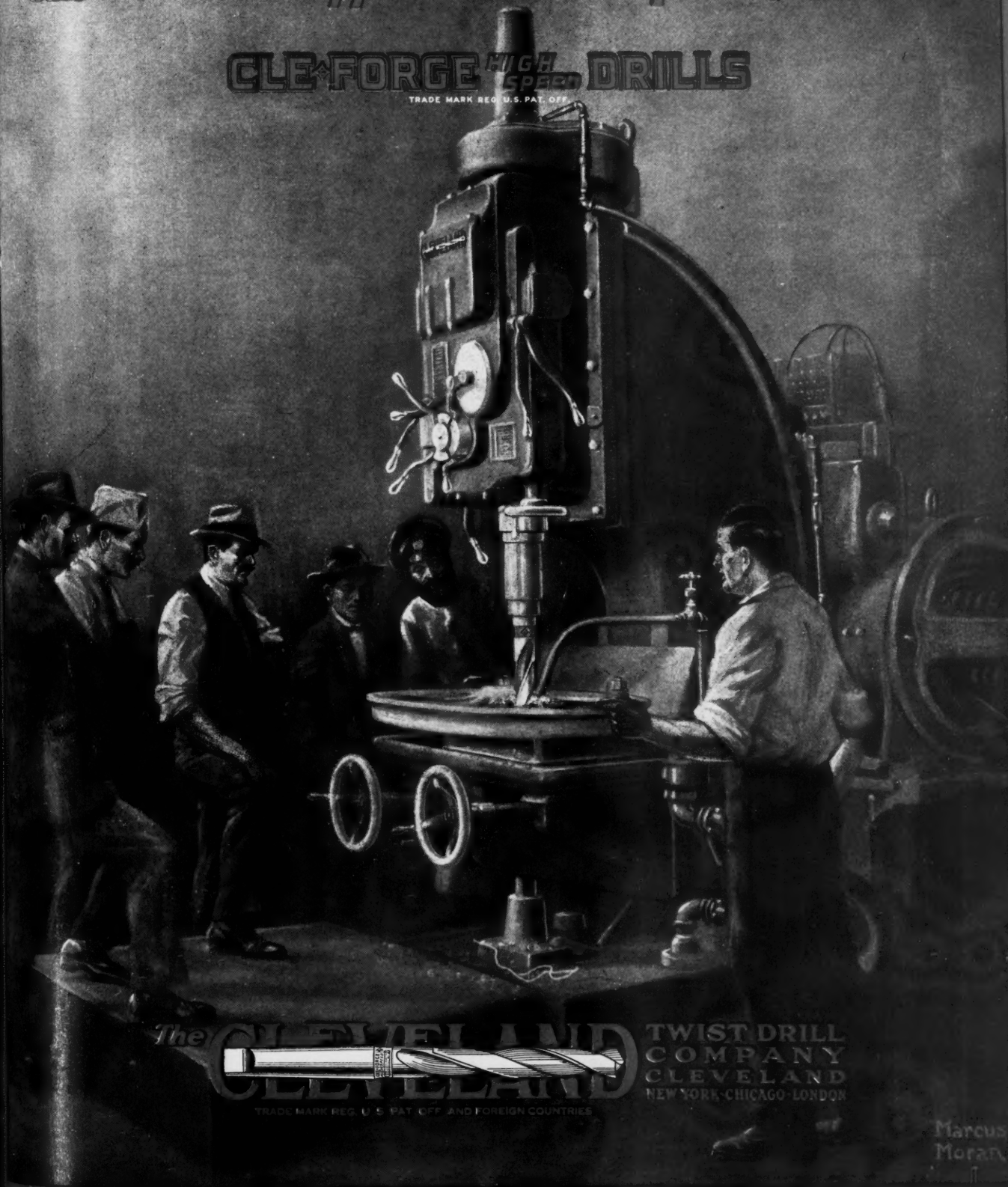
# MACHINERY

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## How the Automotive Industry Selects Equipment

First of a Series of Three Articles Dealing with Important Factors Considered by Equipment Engineers in Selecting Machine Tools, Small Tools, and Tooling Equipment for the Production of Automobiles, Trucks, and Tractors

**N**O industry making use of machine tools gives more thought to the selection of the equipment employed than the automotive industry. Nowhere are the different features of the machines that adapt them to production work more thoroughly examined, or production costs with new and improved equipment more carefully analyzed. It is quite natural that this should be so. There is no other industry that makes use of the number of machine tools that are used in the automotive shops, nor is there any field where the production cost is of greater importance. It has been estimated that the total value of the machine tool equipment in automotive plants—not considering jigs, fixtures, small tools, or woodworking machinery used in body-making—is approximately \$560,000,000, and that for every automobile built, machine tools to a value of over \$25 are actually used up in its construction; that is, on an average, each car built depreciates the value of the equipment over \$25. It is no wonder then that the equipment engineer finds it necessary to use extreme care in the selection of machine tools, and that his deci-

sion must be based on something more than mere opinion.

Because the automotive industry is the largest single buyer of machine tools, and because of the unusually severe requirements placed upon the equipment selected, MACHINERY has undertaken to obtain from equipment engineers and production managers in a great number of important plants throughout the country, their views on the selection of equipment. The considerations that guide these men in the choice of efficient equipment will be recorded in a series of

three articles. The Editor of MACHINERY is not responsible for the opinions expressed or the statements quoted; he can only insure that the information presented accurately records these opinions, obtained through personal interviews with scores of prominent production and equipment engineers in the entire automotive field.

The articles to be presented will deal with the principles that govern the selection of equipment, the main mechanical problems to be considered, the methods by which present and prospective production costs are compared, the procedure in different plants in determining upon the buying of new equipment,

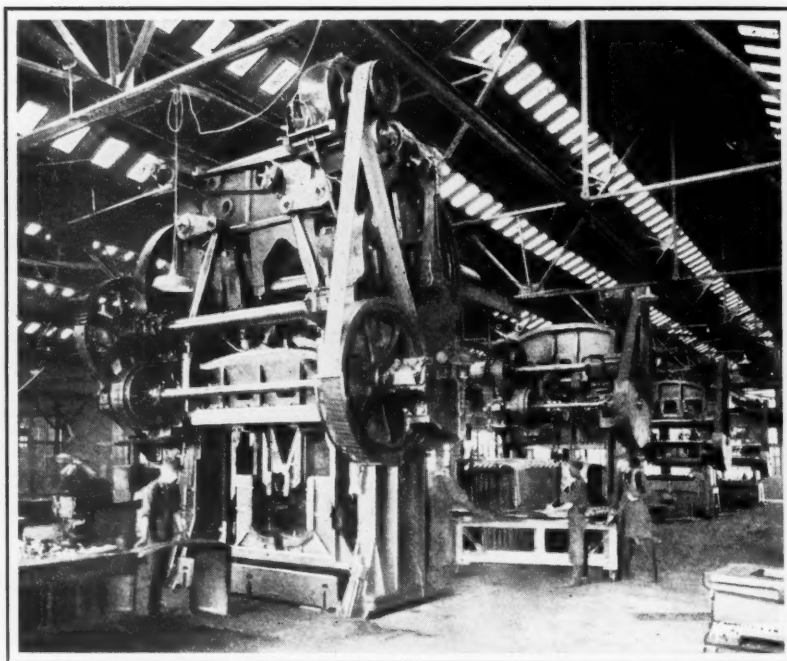
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It has been estimated that the total value of the machine tool equipment in automotive plants, exclusive of tooling equipment and small tools, is more than one-half billion dollars. The automotive industry is the largest single buyer of machine tools, and it places unusually severe requirements upon the equipment selected. Because of the importance, therefore, of the methods used by the automotive industry in selecting equipment, MACHINERY has obtained from production managers and engineers in a great number of important plants, their views on the selection of machine tools and small tools. The considerations that guide these men in the choice of efficient equipment will be recorded in a series of three articles, of which this is the first.

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and the time in which it is expected that new equipment should pay for itself through savings in production costs. Following these general considerations, the special precautions that equipment engineers take in selecting different types of machine tools will be covered; finally, the selection of special tools and small tools will be taken up, and the qualities looked for in buying taps, drills, reamers, milling cutters, and broaches will be touched upon.

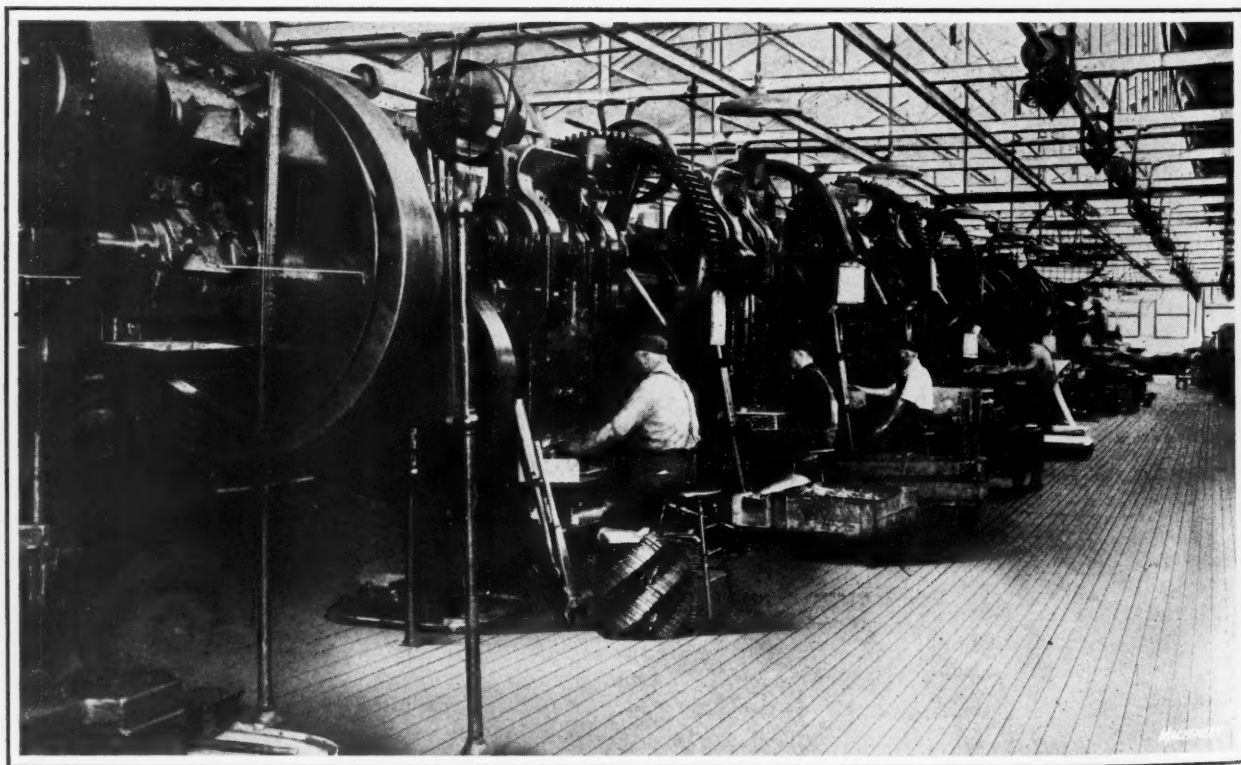
In selecting equipment for an automotive plant, the production required each day must first be definitely determined, because both the methods of machining and the type of machines selected depend primarily on this factor. In the automotive industry, an output of less than 100 cars per day is frequently spoken of as a small output, and only plants producing 100 cars or more per day are spoken of as plants having a large output. Of course, this is a somewhat arbitrary limit, and the machine tool equipment required might vary considerably within the classes referred to. For example, there is considerably more machine tool equipment and a great deal more high-grade machining work done in a plant having an output of, say, 40 or 50 cars a day of the very highest type built, than there would be in a plant producing over 100 cars a day of one of the least expensive grades. Nevertheless, it is true that output per day must be the first determining factor in the selection of equipment.



Making Cowls for the Packard Automobile in One Piece, employing Huge Presses

It is evident that the machine tool builder can produce standard machines at a much lower price than he must ask for a special machine of which perhaps only one unit will ever be designed and built. Hence, it sometimes happens that special machines, although giving a larger daily production, will not reduce the production cost, and many examples are quoted where standard machines would have given better results over a period of years. For this reason, equipment engineers are quite unanimous in stating that standard or semi-standard machines are almost always best, even for special operations, when the output is less than 100 cars a day. When the output is greater, each case may have to be considered separately: A standard machine with special tooling equipment may often give a lower production cost, as compared with a machine built for the production of one part only; but it must also be remembered

If the production is high, the equipment engineer is immediately confronted with the problem, "Shall I buy special or standard machine tools?" A machine specially built for the purpose will probably machine a larger number of parts per day than a standard machine, but the theoretical capacity of the special machine is only one of the many factors that must be taken into account. Among the other important factors are the higher price of the special machine, and the effect of breakdowns on production.



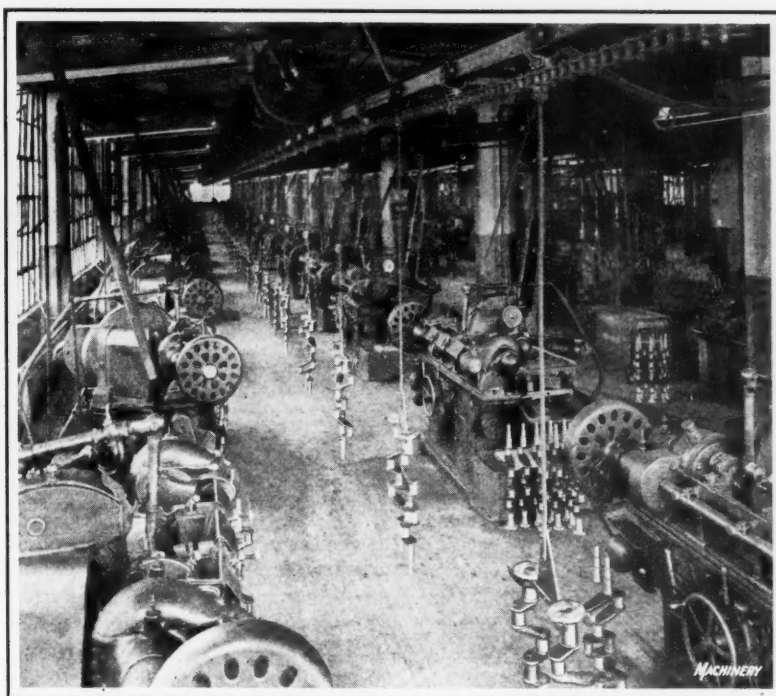
Battery of Punch Presses in the White Motor Co.'s Plant

that in plants with unusually high production, the special machine has made a definite place for itself and proved its advantages under severe conditions.

One important consideration, where special machines are used, is the saving in floor space. Plants producing from 500 to 5000 cars a day, if wholly equipped with standard machine tools, would cover such enormous areas of floor space that the problem of shop transportation alone would become almost insurmountable. The expenses incident to such an increase in floor space, and the additional number of operators required, would make it uneconomical to choose standard machines in preference to efficient special machines in cases of this kind.

#### The Problem of Breakdowns

In selecting special machines for high production, however, the effect of breakdowns becomes a factor of primary importance. What is probably the largest drilling problem ever met with in industry requires the drilling of 240,000 holes daily. For this purpose special machines with eighty spindles were proposed, all the spindles having a common drive, but each drilling one individual piece independently. If one drill should break, the other seventy-nine spindles would have been idle until this drill had been replaced. This immediately suggests the idea that gang drills, where all the spindles are not simultaneously operating on the same piece, should be so designed that each spindle can be thrown out of engagement by an independent clutch, so that a broken drill will not tie up the entire machine. Furthermore, in machines of that type, it is of great value if an



The Crankshaft Grinding Department in the Dodge Brothers' Plant, Detroit, Mich.

versed in the construction of a special machine, and it is probable that the machine would have to be kept out of production for a longer period.

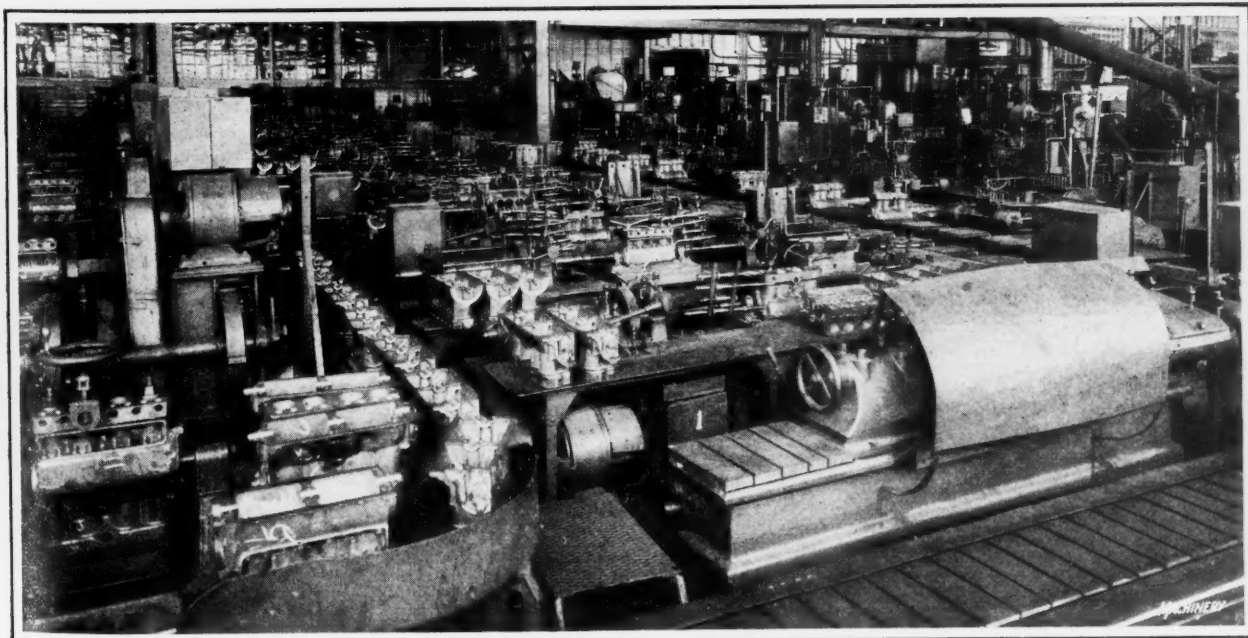
In making a choice between two different types of machines for performing the same operation, therefore, it is very important to consider what will happen in case of a breakdown. For example, if on the one hand one special machine can be bought to take care of the entire output, and on the other, a number of standard machines will be required for the same production, it may sometimes be preferable to buy the type of which several are needed, because in the case of trouble with one machine, the entire production is not tied up. Sometimes it is better to employ one more operator and thereby increase the labor cost, rather than run the risk of tying up the entire production schedule by the breakdown of a single-unit special machine.

#### Influence of Operator on Breakdowns

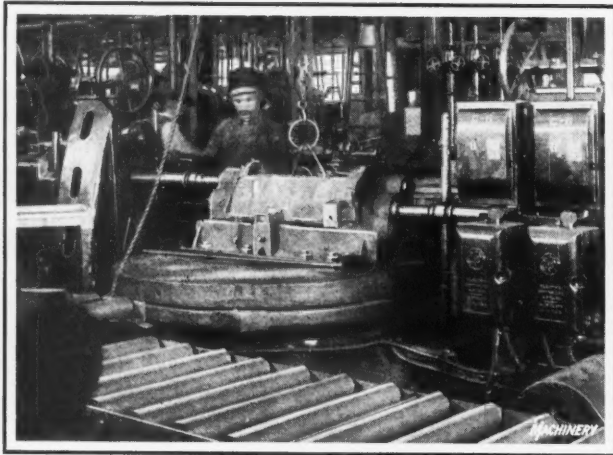
Most production engineers admit that with the present sturdy construction of machine tools, breakdowns are largely

entire spindle can be quickly removed and replaced by a new one in case of damage, so as to prevent serious delays in the operation of the machine.

In favor of the standard machine tool, it may be said that repair parts are generally more easily obtained and repairs more quickly made. The operator, or at least the man in charge of a battery of machines, is likely to be familiar with the construction of a standard machine, and in case something goes wrong he can easily locate the trouble; but he would not be likely to be so well



A Department in the Cylinder Block Line in the Ford Plant



Finish-reaming all the Crankshaft and Camshaft Bearings in the Crankcase at One Setting at the Oakland Motor Car Co.'s Plant, Pontiac, Mich.

due to ignorance or carelessness on the part of the operator. Unskilled labor is responsible for more breakages of machine tool equipment than any other cause. This, however, places an additional responsibility on the machine tool builder. He must, as far as possible, design machines so that they can be operated without danger by men having no mechanical skill or knowledge. The machines must be practically fool-proof. They must be built to be abused.

The fact that maintenance cost depends largely on the operator was brought out in one automobile plant where two machines of the same make, which had been bought at the same time, were pointed out. The maintenance cost of one of the machines had been nearly double that of the other, because of the difference in the two operators.

One equipment engineer quoted a case in which a complicated machine was out of order about half the time. Four machines were in use in the plant, handled by two operators. Breakdowns were so frequent that complaints were made to the builder of the machine. He sent a competent engineer to the automobile plant, who expressed his astonishment at the trouble, because in the builder's own plant he also had four machines of the same type running, all operated by one man, and these machines had been running for three years without giving any trouble.

This brings out an important point. The operator in the machine tool builder's own plant understood the machines perfectly and was able to guard against anything that would precipitate trouble. The ordinary operator in the automotive plant is of a different type, and the machines that he is expected to operate must be practically fool-proof.

Automatic features are desirable, but they should be introduced in the simplest possible way. If skill is required in the operation of a machine intended for the automotive industry, it is unsuitable for the purpose for which it is intended.

#### Selecting the Right Type of Special Machine

In cases where it is evident that special machines will be more advantageous than standard machines from a production point of view, the next problem is to choose between different types of special machines. This, as a rule, is a more difficult choice than to select the best type of standard machine, because the advantages of the different features in special machines are not so generally known or understood. Briefly, the following specific rules are followed by some equipment engineers: (1) Avoid too complicated machines; (2) select the most automatic machine obtainable, provided the automatic features do not introduce undue complications; (3) save floor space, but do not give this consideration greater weight than simplicity of operation and steady and continuous output; (4) select the machine that requires the least attention of the operator, so that one man can run several machines; (5) select the machine that has the fewest parts that are likely to have to be replaced

and one that can be dismantled easily when repairs are required. Sometimes repair parts are cheap enough, but the entire machine has to be dismantled to replace the broken part, and the expense for repairs in that case become excessive.

#### General Considerations in Selecting Machine Tools

In one plant known for the quality of the car it builds, the equipment engineer asks himself five main questions in regard to every machine tool that is required: (1) Will the machine produce the quality of work required and has it the durability to maintain this quality? (2) Will it produce the required quantity per day? (3) What will be the cost per unit, all factors considered? (4) What will be the cost of maintaining the equipment in first-class condition? (5) Is the machine easy to operate, and can it be run by the average operator without difficulty and without danger of breakdowns?

#### Maintaining the Quality of the Work

Assuming that the machine itself is of a type that will produce the required quality of work and that it is accurate when new, the main considerations are: Will it maintain its accuracy? Is it durable? Will it produce as good work a year from now as it does today? Briefly, will it stand up?

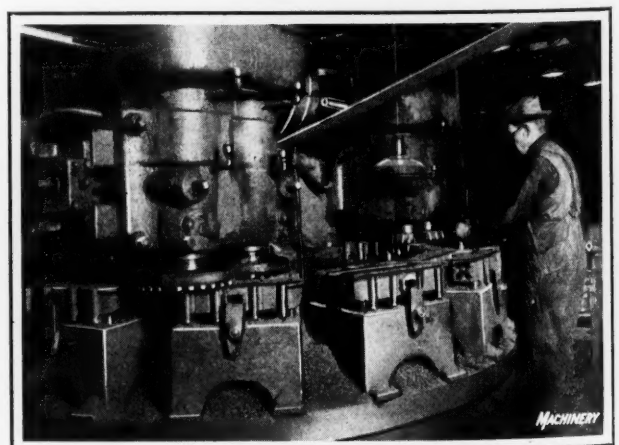
In finding answers to this question, the equipment engineer looks for ruggedness in the machine; ample bearings; wide, strong gears; solid supports for tables and work-holding fixtures; and freedom from "trappy" mechanisms.

In almost all automotive plants, some form of piece-work or bonus system is in effect. This means that the operators "crowd" the machines to the utmost. A machine that is not sufficiently rigid to withstand this hard usage is not suitable for the automotive plant. Automotive machinery is abused, if viewed by the ideas of the old-time mechanic, but it must be built to withstand such usage, because what might be considered abuse in a tool-room is normal use in the production shop.

#### Quantity Required and Unit Cost of Work

Whether the equipment will produce the required quantity per day, is, generally speaking, a simple matter of arithmetic. It is important, however, in checking production estimates to look into the speeds and feeds upon which these estimates are based. Sometimes the machine itself may be strong enough to maintain an estimated production, but the feeds and speeds employed are too high for the tools used, and the tool maintenance cost becomes excessively high. The feeds and speeds must be reduced to a point where the tools will stand up a reasonable time between grindings; otherwise, what is gained in production is lost in tool maintenance cost, and sometimes the unit cost is actually increased in this way.

The production required largely determines how far automatic features can be introduced. Frequently it is found



High-production Milling at the Chevrolet Motor Co.'s Plant, Flint, Mich.

that too highly developed a machine becomes so expensive that the unit cost per piece produced is increased instead of reduced.

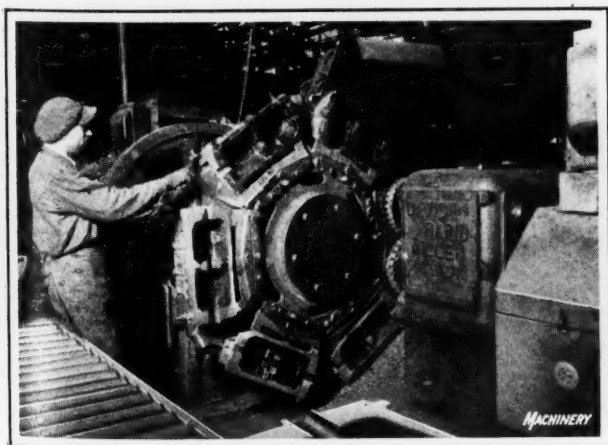
#### Cost of Maintenance

The maintenance item is of extreme importance. In one plant where the machine tool equipment is valued at about \$5,000,000, the cost of maintaining this equipment in first-class condition is between \$400,000 and \$500,000 annually, or nearly 10 per cent of the first cost of the equipment. In another plant, with a production of 10,000 cars a year of a high quality, the maintenance cost is \$250,000 a year, or \$25 per car. These figures indicate the importance of selecting machines that will require a minimum of maintenance expense, as otherwise the repair bills will eat up the production profits. Among the causes of high maintenance cost are too small or poorly designed bearings, clutches that wear out rapidly, inefficient lubrication, shafts too small in diameter, and other defects in design that are likely to cause breakage or require frequent replacements.

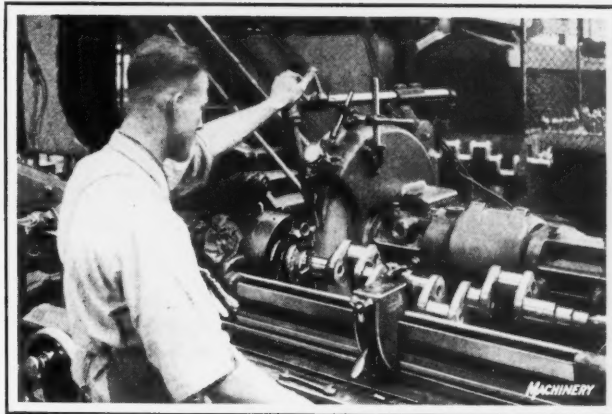
The equipment engineer anxious to reduce maintenance costs should also look into the design of the machine with a view to determining whether there are any parts likely to have to be replaced that are difficult to reach. If the making of repairs is a complicated matter, the machine will stand idle for a considerable period whenever such repairs have to be made. It may be out of the production line at the time when it is most urgently needed, and the loss due to its being out of production may be much greater than the cost of the actual repairs. On some machines there may be only a few parts likely to require replacement, but these parts may be so difficult of access that practically the entire machine has to be dismantled to make some very simple repair or adjustment. For this reason, machines designed on the unit plan, where each mechanism is practically independent of the remainder of the machine, are much to be preferred.

#### Ease of Operation is an Important Factor

Machines that are simple and easy to operate not only permit the employment of less skilled labor, but they also reduce maintenance costs. Most equipment engineers say that in the automotive industry those machines that require the least effort on the part of the operator and the least knowledge and skill are the best machines. The majority of the engineers interviewed consider that the semi-special machines of the semi-automatic type that have been developed during the last six or eight years, meet this requirement better than either the wholly standard machine tool, which often requires considerable skill on the part of the operator, or the most highly developed fully automatic machine, which sometimes becomes too complicated. No hard and fast rules could be given, and machines in every class may be so designed as to make possible the employment of comparatively unskilled labor.



Another Example of High-production Milling on a Rotary Milling Machine at the Chevrolet Plant



Grinding Lincoln Crankshafts

The manufacturer of engines and other parts for automobile builders is confronted with a somewhat different problem in the selection of machine tools from the automobile builder. In the parts plant, the equipment must be so selected that the "line-up" can be changed over with comparative ease from the manufacture of parts intended for one car to similar parts intended for another.

In one plant building automobile engines, for example, the entire requirements for a month's supply of engines for each of three customers can be filled in about eight days. This means that the entire tooling equipment for machining the cylinder block must be changed three times a month. By careful selection of the equipment and by the construction of jigs and fixtures of a suitable character, it has been found possible to change the entire "line-up" for the cylinders in 100 man-hours. Where special machines are used, they must be provided with adjustable features, so that they are applicable to cylinders of different designs and sizes. The same principles apply to the manufacture of any other parts.

The machine tool equipment in a plant of this kind must be flexible and must be adapted to the manufacture of parts for different cars that are not identical in design or size. For example, adjustable features are far more satisfactory in a machine than a design that requires the cutting, buying, or installing of new cams, gears, etc. Each individual case, of course, must be judged on its own merits.

One equipment engineer has a decided preference for machines of standard type with adjustable features for handling small units or parts such as valve tappets, pistons, connecting-rods, piston pins, and other parts that are more or less alike in different automobiles. In such cases, the machining problem is practically the same, and the machine, while in a sense special, can be easily adjusted to meet the requirements for different parts. The same engineer believes strongly in machines with multiple tooling for completing, as far as possible, the machining of a piece in one setting. This reduces handling between operations, which sometimes becomes quite as expensive as the actual operation itself.

Another equipment engineer is very partial to machines that run continuously in one direction, like continuous milling machines, for example. He states that there is less wear on the machine when it runs constantly in one direction, and the longer life of the machine reduces production costs. In selecting milling machine equipment, he prefers machines that will rough and finish at the same time, and that can mill the top and bottom of a piece simultaneously. This not only increases production, but insures parallelism and accuracy in the finished product.

#### Mechanical Features Looked for by Equipment Engineers

Among the many different requirements quoted by production engineers, the following may be listed as having been mentioned by the largest number:

Machines should be rigid enough to stand up to the hard usage of an automobile plant for at least five years.

Adequate lubrication should be provided, the oiling being automatic whenever possible.

Adequate means should be provided for the escape of chips from the moving parts of the machine or from places where they would interfere with the operation of the machine or its tools.

All speed, feed, and operating levers should be so located that the operator can reach them from the position in which he normally stands.

#### The Importance of Accurate Production Estimates

Accurate production estimates are as important to the man who selects machine tools as any other factor. The machine tool builder should not give an estimate of what the machine *can* do, but what the machine can do *economically*—that means, the estimate should be based upon the most economical speeds and feeds for the lowest unit cost, when all factors involving expense are considered.

Another production manager said: "My first consideration in selecting equipment is the machine tool manufacturer. I want to deal with a firm that has a reputation for being reputable and reliable and that has a recognized standing in the trade. Furthermore I want to know whether they are in a sound financial condition, so that it is certain that they will continue in business and be able to supply repair parts and render service during the life of the machine."

#### Standardizing the Purchasing Policy

Several plants have developed a rather elaborate testing system for standardizing on the machines, tools, and supplies to be purchased. Whenever it is decided that a certain make and type of machine is satisfactory for a given type of operations, the same machines are bought right along for replacement or expansion purposes. The advantage gained by this policy is that a smaller number of repair parts need to be kept in stock, the operators become used to the machine, they know how to make minor repairs themselves, and also are less likely to do anything that will cause a breakdown, as their past experience with the machine has taught them what not to do.

In one plant where standards for purchases are entered on special forms, this form contains first the name of the machine, or the trade name of the product. The trade name is generally left out, if possible, so as not to tie down the purchasing department to one source of supply, but when a machine of a given make, or a product of a given trade name, is specifically required, the name is definitely designated. The blank also contains information pertaining to the department in which the machine or product will be used and the particular work or purpose for which it is recommended. In the case of supplies, chemical and physical properties are designated, and the names of firms are given from whom the machine or supply can be bought. Whenever possible, two or more sources of supply are given to the purchasing agent, in order to prevent one seller from monopolizing the business.

In the automobile industry, machines are not bought to

replace old equipment unless the new equipment can be paid for out of the savings in a comparatively short time. Generally speaking, most automobile concerns expect a special machine to pay for itself in from six months to a year. Standard machines are generally expected to pay for themselves in two years. If a machine that is bought for replacement of another machine still in good condition takes three or four years to pay for itself, it is not considered a "good buy," even though the machine is of a standard type.

These requirements on the part of the automobile industry appear at first to be extreme. It seems that an exorbitant return on the investment is expected. When one examines into the reasons for this attitude one finds, however, that the automobile builder is justified in his requirements. The precarious conditions surrounding this highly competitive industry, where conditions change overnight, make it unsafe to figure on investments requiring many years for amortization. A special machine may be of little or no value six months hence; the model for which it was bought may be changed; a competitor may bring out a new model that makes it necessary to follow suit; the public fancy may turn toward a new car, and one-half of the equipment of one of the older plants may be standing idle for a long period. Hence, the automobile manufacturer is wise in avoiding expenditures on which he cannot quickly cash in. What the conditions will be in his particular line of manufacture three or four years hence, only the strongest companies can conjecture with any degree of accuracy.

An example of what can happen is shown by the case of an automobile concern that bought a special milling machine for the cylinder blocks, for which it paid \$9800. This machine was run only one week before the model was changed because of imperative competitive conditions. The machine could not be used on the new model, and after it had been kept in storage for three years it was sold for \$500. In another case a \$16,500 machine was used for manufacturing parts for only 1000 cars; after that, the plant was closed down because of financial difficulties. This machine should have been good for a production of from 60,000 to 75,000 cars, and it would have paid for itself in one year, but it had a chance to work on only one month's production.

In order to determine when it is good economy to replace an old machine, one automobile company, at least, keeps a complete record of the repairs on each individual machine in the plant. When repairs begin to become frequent and costly, the equipment engineer watches the record of the

machine, and as soon as it is evident that it will be cheaper to buy a new machine than to keep on repairing the old one, a new machine is installed.

The next installment of this series of articles will deal with the actual procedure in different plants in selecting new equipment, and will briefly outline what the equipment engineer looks for in different types of machine tools, as, for example, turning machines, milling machines, drilling machines and grinding machines. This will be followed by an installment on the selection of small tools, taps, drills, cutters, and reamers.



# A Basic Allowance and Tolerance System

By JOHN GAILLARD, Engineer, American Engineering Standards Committee, New York City

IN the article "A Basic Allowance and Tolerance System," by W. L. Hindman, published in August MACHINERY, special advantages are claimed for the principle of distributing the tolerance on the hole, in a bilateral system, as a plus variation from the basic size of one-third the tolerance, and a minus variation of two-thirds the tolerance. The following comments are made in the belief that there are certain inconsistencies in the statements made.

## Use of Term "Uni-bilateral System"

As to the name, there is obviously no reason for calling the proposed system "uni-bilateral," as it is entirely *bilateral*, the two limits for each mating part lying on both sides of its basic size. Indeed, there is no essential difference in this respect between the tolerance systems depicted by the diagrams C and D in Fig. 1, page 934. The term "bilateral" simply expresses that the tolerance is given partly on each side of the basic size, and does not indicate in what ratio the tolerance shall be distributed—whether in equal parts, one-third and two-thirds, or in any other way. Inequality between the two parts of the tolerance on both sides of the basic size line, as a matter of principle, is no novelty; it is inherent, for example, in the British "Newall system" of tolerances, in which, however, the larger part of the tolerance is given as a plus variation, and the smaller one as a minus variation, the inverse of the method proposed.

## Interchangeability Obtained with Unilateral System

On page 934, it is implied that from a standpoint of workshop practice, the unilateral system is inferior to the special kind of bilateral system proposed. Before commenting on this phase of the question, it may be said that the author fails to compare the merits of the unilateral system and any bilateral system in general, on the basis of the most essential function of a tolerance system in mass production, namely, to insure, to the greatest possible extent, interchangeability between mating parts. With regard to the statement, on page 937, that interchangeability is equally guaranteed through the use of the unilateral and the bilateral systems, it may be emphasized here that interchangeability is guaranteed in a greater number of cases of fit with the unilateral than with the bilateral system, as explained in the following:

The unilateral system may be applied as a "basic hole" or as a "basic shaft" system. In the "basic hole" system, all holes of a certain nominal size have the same *low* limit (the nominal size), independent of their tolerance. All clearances are measured downward, and all interferences upward from the nominal size line. In the "basic shaft" system, all shafts of a certain nominal size have the same *high* limit (the nominal size), independent of their tolerance. All clearances are measured upward, all interferences downward from the nominal size line.

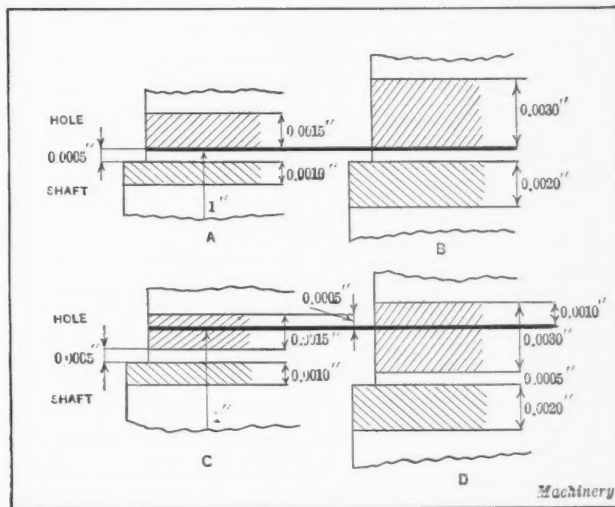
It is not the place here to discuss the pro and con of the "basic hole" and "basic shaft" systems, as this has no bearing on the problem under consideration. As, in the article referred to, the nominal size has evidently been adopted as the basic size for the hole (which is called "mean size," although one would expect this name to be used for the size half way between the limits), the unilateral "basic hole" system will be used in the following examples, for ease of comparison.

If the case of fit given as an example on page 935 for mating parts with a nominal diameter of 1 inch were "translated" into the unilateral system, it would be represented

by diagram A in the accompanying illustration, as against Mr. Hindman's system, which is shown by diagram C.

Let it be assumed that during production it is desired to change the tolerances on the mating parts. They may, for example, have to be widened because the original tolerances, when adopted for a new product, were made smaller, in order to remain on the safe side, than was proved to be strictly necessary. If the minimum clearance remains the same, the new conditions will be as shown by diagram B for the unilateral system, and as shown by diagram D for the system proposed in the previous article.

A comparison of diagrams A and B, on the one hand, and C and D on the other, will reveal at once that a maximum size original shaft (see diagram A) will still give a running



(A and B) Diagrams showing Interchangeability obtained with Unilateral System; (C and D) Diagrams showing Lack of Interchangeability in the Proposed Bilateral System

fit with a minimum size revised hole (diagram B), this combination, in fact, having the same minimum clearance as existed in the original case shown by diagram A. In other words, the original and the revised holes and shafts are perfectly interchangeable, without limitation.

Between the cases represented by diagrams C and D, however, no such perfect interchangeability exists. The maximum size original shaft (diagram C) will give an interference fit, instead of a running fit, with the minimum size revised hole (diagram D), the shaft being larger than the hole. Obviously, there is quite a range of combinations between original shafts and revised holes that do not comply with the requirement of minimum clearance for the running fit.

The foregoing example has for its purpose not so much to prove the superiority of the unilateral system in this special, more or less exceptional case, as to make clear the principle that the unilateral system, by keeping all the possible actual hole sizes rigorously on one side of a fixed basic size line, provides thereby the guarantee that any given shaft will be interchangeable with all minimum holes of the same nominal size, whereas this is not the case with bilateral systems, of which the one proposed in the previous article is a special kind.

Incidentally, it may be mentioned that the Sectional Committee on the Standardization of Plain Limit Gages for General Engineering Work, appointed under the procedure

of the American Engineering Standards Committee, and sponsored by the American Society of Mechanical Engineers, has adopted the unilateral system of tolerances as the sole basis for the "Tentative American Standard for Tolerances and Allowances for Machined Fits in Interchangeable Manufacture."

The national standardizing bodies in Austria, Germany, Holland, Sweden, and Switzerland have also adopted exclusively the unilateral system as standard, and the British national standard, while giving tables for both the unilateral and the bilateral systems, recommends the use of the unilateral system in cases where it does not conflict with predominant present practice.

#### Advantages Claimed for Proposed Bilateral System

Certain advantages are claimed for the proposed system from the standpoint of economy in the purchase and the use of tools for producing holes, especially reamers. The basic idea is evidently to have the high limit for a hole of a certain nominal size coincide with the maximum size of a hole produced with a new "standard" reamer of the same nominal size as the hole. In other words, the high limit of a 1-inch hole should be chosen so much larger than 1 inch that a new 1-inch reamer, having the maximum size permissible for such a reamer, will produce this high limit hole.

According to a statement made in the previous article, one of the largest reamer manufacturers in the United States furnishes his reamers within limits that have, for a certain range of diameters, a definite fixed position with regard to the nominal size. For example, for reamers from 1/2 inch to 12 inches in diameter, these limits are mentioned as being nominal size plus 0.0005 inch, and nominal size plus 0.0008 inch.

There is to be taken into account a certain over-size reaming effect of a new reamer, due to the great keenness of its edges. Although there may be a minute difference in the absolute amount of this effect for different reamer diameters, this may be disregarded as of secondary importance in comparison with the influences that are being considered here. Let it therefore be assumed, for simplicity's sake, that a new reamer of any diameter within the range 1/2 inch to 12 inches, reams 0.0001 inch over-size with regard to its actual (that is "measured") size. It will then be found, in view of the two facts just mentioned, that a new reamer with a nominal diameter of from 1/2 inch to 12 inches, produces a hole whose maximum size is equal to the nominal diameter of the reamer, plus 0.0008 inch (for the tolerance), plus 0.0001 inch (allowance for reaming over-size). In other words, the maximum hole (produced by the maximum size new reamer) is 0.0009 inch larger than the nominal size of the hole (which is also the nominal size of the reamer).

Evidently, then, if it is desired to have a new reamer produce the maximum permissible hole, the rule for setting the upper limits for holes with diameters from 1/2 inch to 12 inches should be to make the high limit for the hole 0.0009 inch larger than its nominal size, and not one-third of the tolerance, as proposed.

In general, the tolerance on the hole will vary, first (the nominal size of the hole remaining the same), according to the kind of work, and second (the kind of work remaining the same), according to the diameter. On the other hand, the difference between the nominal size of the reamer and the maximum hole produced by the reamer remains constant for a certain range of nominal reamer sizes. It is therefore obvious that one-third of a rather widely varying tolerance figure for the hole cannot possibly always coincide with the constant "surplus figure" to be added to the nominal reamer size. However, it will be well to demonstrate this by means of the following concrete example.

In the example given on page 935 for a 1-inch hole and shaft, it is assumed that the limits required for the hole are 1.0005 inch and 0.9990 inch. Adopting, again, the constant figure 0.0001 inch for "over-size" cutting of a new reamer, the nominal size of the reamer to be selected for such a hole should be  $1.0005 - 0.0009 = 0.9996$  inch.

Now, let it be assumed that for another kind of work the tolerance on the 1-inch hole has to be 0.0030 inch, distributed, according to the proposed system, as a permissible plus variation of 0.0010 inch, and a permissible minus variation of 0.0020 inch, the limits for the hole thus being 1.0010 inch and 0.9980 inch. Reasoning along the same lines as before, it will be found that the nominal size of the reamer to be used in this case should be  $1.0010 - 0.0009 = 1.0001$  inch.

There are two possibilities for complying with the requirements in each of the cases cited:

1. *Special* reamers are used with diameters of 0.9996 inch and 1.0001 inch, respectively.

2. A "standard" reamer with a nominal size of 1 inch is used in both cases, and the basic sizes of the holes are *shifted away* from the nominal size to suit conditions, namely to 1.0004 inch in the first case, and to 0.9999 inch in the second case. In fact, the upper limit for the hole will then be, in both cases, 1.0009 inch ( $1.0004 + 0.0005$ , and  $0.9999 + 0.0010$ , respectively), equaling the maximum hole produced by a new 1-inch reamer.

Solution (1) must be left out of consideration, as it is claimed that no special reamers are required in the proposed system.

The application of solution (2) would mean that a constant level above nominal size is maintained for the high limit of the hole, which amounts to the adoption of a rather uncommon kind of unilateral system of tolerances for the holes, namely a system with a constant high limit, instead of a constant low limit. Such a solution need not be considered further. It has no practical utility from a technical standpoint, and, moreover, it does not conform to the system proposed, in which the nominal size is maintained as the basic line from which the (unequal) permissible plus and minus variations are measured (see Fig. 1, diagram D, page 934). In this system, therefore, the high limit of the hole lies at a greater distance above the nominal size, the larger the tolerance is, whereas solution (2), previously mentioned, required a constant high limit, independent of the magnitude of the tolerance. Neither of the two solutions discussed being compatible with the requirements of the system proposed, it is not clear how the system can present the advantages claimed for it.

The advantage of showing "bull's-eye dimensions" in mass production, discussed on page 936, is imaginary. In order to obtain the greatest economy of production (cost of tools, tool setting, inspection, etc.), the initial set-up of the tool should be as close as possible to one limit of the parts to be manufactured, and the tool may then wear down until the other limit of the parts is practically reached. This means that the whole range of sizes lying between the two limits is gradually traversed, and consequently there is no reason for "aiming" at one special dimension; in fact, to do so, would be inconsistent with manufacturing economy. Also, it is obviously inherent in the nature of inspection by means of "Go" and "Not Go" gages, which is common practice in interchangeable manufacture, that *any* size between the limits is acceptable and that, therefore, none is practically preferable to another.

\* \* \*

#### NATIONAL ASSOCIATION OF FOREMEN

The rapid growth of foremen's clubs in many cities throughout the United States, coupled with the keen interest of both the management and the foremen in the subject of better foremanship, has led to a plan to expand the Ohio Federation of Foremen's Clubs so as to take in clubs and individuals outside of Ohio. T. B. Fordham, president of the Ohio Federation of Foremen's Clubs, Dayton, Ohio, has called a meeting of delegates from the various city foremen's clubs and invited all others interested to meet at the Y. M. C. A. at Dayton, on October 8 at 10 o'clock A. M., for the purpose of forming a national association of foremen.

# Determining the Quality of Leather Belting

By LOUIS W. ARNY, Secretary, The Leather Belting Exchange, Philadelphia, Pa.

IT has always been difficult for those only casually informed about leather to distinguish between inferior and superior qualities of leather belting. The leather belting market is full of inferior product, one cause of which is the fact that at a casual glance, the inferior and superior look so much alike that relatively few can distinguish between them. The Leather Belting Exchange, Philadelphia, Pa., is distinctly interested in seeing that the industries secure a good quality of belting, because suitable belting is the cheapest and most satisfactory medium for the transmission of power, and because a large experience in research work in leather belting has shown so large a difference between the practical values of good belting and bad. Furthermore, satisfactory transmission by belts must increase the demand for belt drives, while unsatisfactory transmission must decrease it.

## Standard Tests for Determining the Quality of Leather Belting

Efforts to make possible a closer discrimination between qualities have been made through the establishment of stan-

tion of belting, the question therefore becomes important whether the belt is made from the portion above a line drawn 15 inches from the backbone, or whether it is made from that portion lying further down, and nearer the belly.

This can be determined with a reasonable degree of accuracy by the "piping" tests provided in the specifications. These tests are based on the fact that the leather in the lower half of the hide, with its longer and looser fibers, is softer and spongier than the upper part, and that the grain surface of the leather is not so firmly attached to the inner fiber; hence, in bending this leather, it will develop usually into wrinkles or "pipes" in the grain. It is possible to produce "pipes" in almost any piece of leather by bending it often enough and close enough, and applying sufficient force, but to make the test perfectly fair, the specifications provide that a single leather belt shall not show pipes, or piping, when bent over a form 2 inches in diameter; or a double belt  $7/64$  inch thick when bent over a form 4 inches in diameter; or a double belt  $19/64$  inch thick when bent over a form 6 inches in diameter.

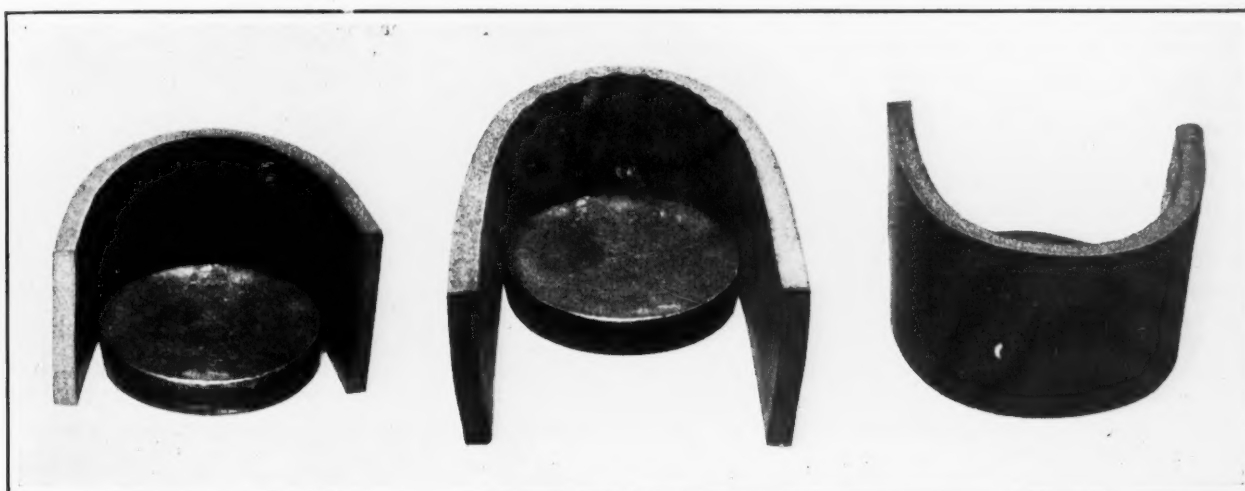


Fig. 1. Example of Good Leather, which does not "pipe" when bent over a Form 2 Inches in Diameter

Fig. 2. Example of Poor Leather, showing badly piped Grain, when bent over a Form 2 Inches in Diameter

Fig. 3. Example of Poor Leather, showing Surface or Grain Cracks when bent over a Form 2 Inches in Diameter

dard specifications for leather belting, by collaboration between the Leather Belting Exchange and the United States Bureau of Standards at Washington. These specifications go very fully into all the details of quality; and where the material is properly inspected and tested, discrimination between the good and the bad is made with certainty. However, the application of these tests is difficult, except for those concerns who have testing laboratories, and those not so equipped must depend upon the judgment of persons not well informed on leather. Hence too much inferior material enters our shops.

The specifications mentioned require certain qualities and they provide numerous tests for determining these qualities. All of these tests are necessary to classify the quality of the belt, but in many cases definite inferiority can be decided by the use of a few simple tests, without going very far into the specifications.

### The Piping Test

It is desirable that belts should be made from the upper half of the side of the animal, and this constitutes, roughly, according to the size of the animal, a strip equivalent to about 15 inches each side of the backbone. In the examina-

tion of belting, the question therefore becomes important whether the belt is made from the portion above a line drawn 15 inches from the backbone, or whether it is made from that portion lying further down, and nearer the belly. Practically all belly leather stock will show piping under this test, even when it has been rolled hard to prevent it from showing, and hence it is not desirable for belting purposes. Occasionally, also, pieces from the upper part of the hide will show piping under this test, but regardless of the part of the hide from which the piece is taken, the presence of piping indicates a loose grain and a flabby fiber in the leather, which is not conducive to durability in the belt, and in most cases indicates the presence of belly stock.

### Testing for Cracking of the Leather

There is another test to be applied by bending the leather over the same form, with the grain side on the outside, to detect cracking in the grain, and if this test shows that the leather cracks, that is, if it develops a series of minute cracks running across the width of the belt, it may be deduced that the material either is not properly tanned or is not properly curried, and that it is not suitable for good belts.

It is not possible to determine much about the quality of the leather by its "feel," because the makers of inferior commercial grades have learned the trick of rolling and jacking their leather, and filling it with materials to solidify

it, which makes the "feel" very deceptive, but the piping test described in the foregoing, if properly applied, will expose it.

#### Tensile Strength Test

The next important test is the tensile strength test, though it is important only in connection with other tests, since the poorest part of the hide shows the greatest tensile strength. As hides vary so much in substance and strength in their different parts, it is not possible to test one piece of leather and to say that that is the tensile strength of the belt.

The specifications meet this condition by providing that the test shall consist of five test specimens, selected at random from different parts of the sample being examined, and that these shall show an average tensile strength of 3750 pounds per square inch of section, with a minimum of not less than 3000 pounds per square inch. This is an assurance against bad tanning, and will expose any leather that is burnt by any of the processes of tanning. Of course, 3750 pounds per square inch is a relatively low tensile strength for this material, for in most cases it is as high as 5000 to 6000 pounds per square inch, but it is sufficient to determine that the leather is not inferior; and, furthermore, it is about ten times as much stress as the belt ever will be required to withstand in actual service.

#### Stretch or Elongation Test

The stretch or elongation test should be applied with the tensile strength test, by placing parallel gage marks 2 inches apart on the test specimen, stopping the machine when the tensile strength indicated reaches 2500 pounds per square inch, and then measuring the elongation. The elongation must not exceed 15 per cent, and this is quite liberal, for most of the better belts will not elongate to this extent. A high tensile strength, accompanied by a large stretch and small elasticity, also indicates belly stock, while a somewhat lower tensile strength, accompanied by not over 15 per cent stretch and better elasticity, indicates center stock. These tests will determine the part of the hide from which the belt has been made.

The chemical tests provided in these specifications are very interesting, and where very accurate results are desired they are necessary, but the tests already enumerated will demonstrate whether a leather belt is cut from the upper or lower half of the side, and whether it may be depended upon for good service in the shop, because if it is markedly defective under the chemical tests, such deficiencies probably would show in some one of the physical tests named.

#### Thickness of Belting

Other requisites of a good belt are that it shall be of the proper thickness. Sometimes this is designated by weight per square foot, but care should be taken to see that the belts offered should measure in thickness, or should weigh, according to the specification of purchase. Medium or regular singles, for instance, should measure from 10/64 to 12/64 inch; that is, the narrow sizes—1 1/2 and 2 inches—should measure 10/64 inch, and the wider sizes—4 to 6 inches—should measure 12/64 inch, and the weight should be from 14 to 16 ounces per square foot. This is especially necessary in buying double belts. Care should also be taken to see that the belts shall be accurate in width; variations in width of more than 1 per cent are not tolerable.

Belts must be purchased for their substantiality, but a belt may be made of excellent leather and still be inefficient as a transmitter of power, because the latter quality depends almost entirely on the treatment that has been given the grain or hair side. Many buyers think that if the belt feels firm and solid it must be leather of a high quality, and if it is finished highly, with a brilliant gloss, it appeals to the eye as well finished material, but this is a mistake.

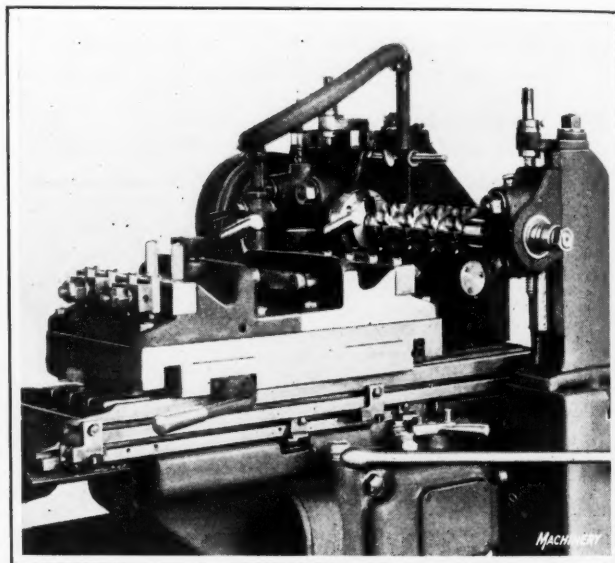
The firmest and most solid leather is attained by heavy rolling and jacking, while the high polish is produced by

jacking, and both processes are destructive of the fibrous grain surface. The contact of the belt with the pulley is formed by the elastic cushion of the natural grain, and when this is destroyed by mechanical action, the capacity for making this close pulley contact is greatly reduced, so that, under test, the rolled and jacked leather transmits little more than half as much power as that with a natural finish. The best belt makers take care to preserve the characteristics of the natural grain, so that their belts will be not only durable, but also able to carry a full load on installation, and a large overload after they have run a few hours.

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### MILLING BRAKE ADJUSTING NUTS

In milling one end of service-brake adjusting nuts to an included angle of 120 degrees, one automobile plant obtains an hourly production of 428 nuts by employing the automatic milling machine here illustrated. On the table of this machine there is mounted an indexing base which is arranged with a fixture at each end for holding four pieces in parallel. The work is held vertically in the vees of a hardened



Automatic Milling Operation on Automobile Service-brake Adjusting Nuts

steel block by means of two clamps operated by a single cam through a lever. The entire milling cycle is automatic, the only work required of the operator being to reload the pieces in the idle fixture and index the base.

Cutters 4 inches in diameter, of a special angular form, are mounted on a 1 1/4-inch arbor for the operation. The cutter speed is 66 revolutions per minute, while the feed is 3.87 inches per minute. The nuts are milled from cold-rolled steel. Cutting lubricant is supplied copiously during the operation. The machine is a 24-inch plain automatic milling machine built by the Cincinnati Milling Machine Co.

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Experiments just completed at the Bureau of Standards at Washington show that the old rule to use the least possible amount of water that will make concrete workable is just as applicable for producing great strength in the new quick-hardening high-alumina cement, as it is with concrete made from Portland cement. In one experiment, a decrease of 1 per cent in the amount of water used was found to increase the strength of the concrete as much as 26 per cent. A gravel concrete made with the new quick-hardening high-alumina cement generally develops as high a strength in twenty-four hours as a Portland cement concrete would develop in twenty-eight days. This quick hardening feature is particularly valuable where delays in waiting for the concrete to harden and attain its strength are costly.

# Foreman Training\*

By LOUIS RUTHENBURG, General Manager, Yellow Sleeve Valve Engine Works, Inc., East Moline, Ill.

THE major objectives of a manufacturing organization are usually permanence and profits. Given a saleable product, a competent selling organization, and sufficient financial strength, permanence and profits depend upon the high quality and low cost of the product, as compared with the quality and cost of competitive products. Good foremanship is a most important factor in establishing and maintaining high quality and low cost.

Can the quality of foremanship be bettered by a type of training that is of a very different nature from the training the average foreman has received? This question cannot be answered until we have carefully observed the conditions under which the foreman works and have established clearly in our minds the essential nature of this job.

## Present Methods of Management Require a New Type of Foreman

When we examine average conditions in automotive shops, it is apparent that processing is predetermined. Tools are designed, made, stored, issued and accounted for by specialists. Labor is hired and fired by a personnel organization. Piece-work prices or bonus payments are established by the rate department. Material is moved by direction of the dispatching organization. Machine tools are maintained by an organization independent of the operating department. Work is accepted or rejected by the inspection organization, under rules established by the engineering division.

Hence, if we start with the assumption that the foreman is to be held fully responsible for every activity that affects the operation of his department, we are immediately confronted by the fact that he cannot be given direct authority over certain functionalized services that affect the operation of his department. He must, therefore, develop that higher type of executive ability that can obtain results without the club of direct authority. He must understand the reasons for and the methods of operation of these functions. He must learn the arts of persuasion and diplomacy.

In short, instead of regarding the departmental foreman as simply the master craftsman of his department, we must come to look upon him as the business manager of his department. Business management, even of a factory department, involves an understanding of many things that the foreman cannot learn thoroughly or systematically in his craftsmanship experience. Business problems usually resolve themselves into one or more of three elements, which may be briefly tabulated as follows:

1. Technical elements—the “know how”—the practical phase.
2. Economic elements—the “dollars and cents” relationship—the “will it pay” phase.
3. Human elements—salesmanship in its broader aspects—the “getting cooperation” phase.

Foremen, by virtue of their craftsmanship training, are usually most efficient in the first element of business management, but they are quite generally deficient in the second and the third elements.

## Knowledge of Economic and Human Elements Essential

It is no more necessary that a foreman should be an economist or a psychologist than that he should be an academically trained engineer. But if he is to assume the broader responsibilities of departmental management, he should have a working knowledge of simple economic principles and human reactions, just as surely as he should have his practical trade knowledge. He should have a clear insight into

such economic factors as equipment depreciation, tool cost, scrap charges, supply costs, supervision and inspection charges, and the like, in their relation to direct labor charges and total costs.

When I refer to a practical knowledge of human reactions, I am trying to convey the thought that foremen should have qualifications of leadership. They should be able to inspire enthusiastic cooperation rather than passive acquiescence among the men under their direction. They should know how to select and train and keep good men. Sound teaching ability among the foremen is a most valuable asset to an organization.

## Need for Systematic Training

I sometimes think that we have fallen into the very general error of assuming that a foreman's duties are simply a logical extension of the craftsman's duties. Certainly the average foreman has had no systematic or intensive instruction in any science or art other than those relating to his craft. The average foreman is simply a skilled craftsman, naturally endowed with a little more intelligence or ambition than his fellow workmen—all essential characteristics in a foreman. But without systematic training, his knowledge of simple economic values and of the art of dealing with men in positions subordinate, coordinate or superior to his own, must necessarily be accidental, instinctive, or non-existent. That foremen function at all effectively is a great tribute to average human intelligence and adaptability.

What actually happens is that the successful foreman is forced by his environment, after he has become a foreman in name, to absorb sufficient information beyond his trade knowledge to permit him to “get by” in competition with other men who have been as inadequately trained as himself. It must be admitted that such a process is intolerable in a day in which waste and lost motion are abhorred and in an industry which boasts of high quality and low cost.

## Feasibility of Foreman Training

Having examined some of the conditions surrounding modern foremanship, may we briefly consider what can be done in a practical way to supplement the average foreman's qualifications by systematic training? There have been many attempts at foreman training which have either failed or produced indifferent results. These failures prove little except that wrong methods were employed. There are certain principles involved in foreman training which must be observed, if satisfactory results are to be attained. Education is a “leading out” process—not a “forcing in” operation. Many attempts at foreman training have failed because this elementary principle has been disregarded.

Consider, for example, the case of old Bill Jones, who has been foreman of the turret lathes for the past six or eight years. Without warning or preparation the boss says to Bill, “Bill, we're going to give you a chance to learn foremanship. Look, here's a book written by Professor Hibrow.” Inasmuch as it is the boss talking, Bill doesn't talk back. But without any doubt Bill knows that the boss is temporarily insane. Where did he get that stuff? Teach him foremanship? Why, hadn't he been holding down a foreman's job for years? And he'd like to see the bird that could tell him anything about turret lathes! Certainly Bill sits in on the classes. He figures that a foreman has to put up with a lot of foolishness in his shop, anyhow, to keep from getting in wrong, and as long as the rest of the bunch stand for it, why should he pass up a good job? But learn anything? Say, don't make him laugh! You don't learn how

\*Abstract of a paper presented before the Production Meeting of the Society of Automotive Engineers in Cleveland, Ohio, September 14, 1925.

to be a foreman out of a book. What do these white collar birds know about getting production out of a string of turret lathes, anyhow?

With such a lack of receptiveness on the part of the man to be trained, is it remarkable that the result of "foreman training" has in some cases left much to be desired? Until an attitude of enthusiastic receptiveness exists or has been created among the men to be trained, attempts at training will produce disappointing results.

#### The Best Leadership is Required for Proper Training Results

Then it must be remembered that the best training results can only be expected under able leadership and strong personal inspiration. It should be generally recognized among the foremen that the general superintendent or the works manager or the vice-president in charge of production, or even the general manager or the president himself, are enthusiastically interested and believe firmly in the project. A leading company official should take enough time to understand the matter, talk to the foreman about it, and supervise the program.

Although the routine work must be delegated in large part to an able subordinate, this subordinate must have the chief executive's enthusiastic support and help. And be sure that the company official who gives this matter his attention is a practical manufacturing man. In this particular matter, your foremen are usually, and for obvious reasons, uncertain of the leadership of other types.

Then be sure that the routine lecturer is a *teacher*. He must command respect for his knowledge and ability. He must be able to explain abstract principles by concrete illustrations. He must know your organization methods intimately. Other able speakers on special subjects should be enlisted to relieve him from time to time.

#### Preparation of the Text for the Course

In selecting or preparing text material and lectures, it should always be kept distinctly in mind that while we are endeavoring to teach principles, an average mind thinks in concrete terms and, therefore, finds it difficult to absorb abstract ideas. Consequently, every principle or abstract thought presented must be immediately and as graphically as possible illustrated by some concrete practice with which all the men in the class are familiar.

Such illustrations can best be drawn from your own plant practice. If you do not prepare your own text material, you must depend upon your lecturers and teachers to impress the principles and facts set forth in the text by means of graphic examples drawn from specific practice with which the foremen are intimately familiar.

The initial text material and lectures may well deal with the evolution of industry, starting with the story of individual craftsmen and their guilds, cottage industries, the change wrought by the great inventions of a century ago, tracing division and subdivision of labor, and the ever increasing specialization to the modern system of functionalized control. From this beginning it is an easy transition to an explanation of modern methods of processing, plant layout, machine load analysis, stock control, planning, incentive methods of wage payment, time study, job analysis, methods of selecting and teaching efficient workmen, or any subject matter that may seem a desirable part of a foreman's knowledge and mental equipment. The text matter should present definite information as interestingly as possible.

#### Can Such a Training Course be Made Successful?

The successful application of such methods and text material has been demonstrated in large organizations. Similar methods have been used successfully for training groups of foremen from small and greatly diversified industries. When training is soundly started with any group, it has a tendency to be self-perpetuating in interesting and constructive developments. To cite only two examples with which I am intimately familiar: Foremen and superintendents at the Delco plant in Dayton have continued their classes with great enthusiasm and profit for five years, advancing each

year to new and interesting studies of industrial subjects. A class of less than one hundred foremen from diversified industries, which met in the Dayton Y. M. C. A. five years ago, has evolved into the Ohio Federation of Foremen's Clubs, a fine organization of over three thousand men.

The feasibility of foreman training has been proved in so many varied industries and under such widely different conditions that the adoption of a training program is largely a matter of putting it into effect, with proper regard for a few basic factors carefully adapted to the particular conditions of each plant.

#### Foreman Development and Promotion

Training the foreman after he has become a foreman in name presents some interesting and difficult problems, because we are trying to add certain qualifications which the man should have had before he was given his foreman's job. He should have attended an intensive training school after he had thoroughly learned his trade and before he was put in charge of men. May we now examine one or two successful attempts to establish definite training in foremanship preliminary to assignment to supervisory jobs?

#### Examples of Successful Training for Prospective Foremanship

A number of years ago the Goodyear Tire & Rubber Co. organized what is known in their plant as the Flying Squadron. This organization has for its membership men who show promise of developing into successful plant executives. They are thoroughly grounded in all phases of processing and plant routine, and in the fundamental principles of successful manufacturing. When men are graduated from the Flying Squadron into minor foremanships, they have built the foundation for a successful career.

A similar plan has been in effect for some years at the Dayton Engineering Laboratories plant. The scheme is quite simple. Candidates for the "Squad" are usually drawn from among the departmental job setters or from applicants who have had technical school training. With two thousand people on the factory payroll, there are usually six or eight men on the "Squad." Foreman turnover at the Delco plant is very small. The squad men are trained in motion study, rate setting, stock handling and accounting, and the like, by being assigned to jobs in these departments. They are given definite training in foremanship in which they are required to read certain text material, attend lectures, and pass examinations. When a vacancy among the "job foremen" occurs, a squad man is usually given the position. Squad graduates almost always become successful foremen.

#### Foreman Rating

Some six years ago I had the good fortune to establish contact with Dr. Walter Dill Scott and his able staff immediately after their very interesting personnel work in the army had been given pause by the signing of the armistice. Under the immediate direction of Dr. J. W. Hayes, we set out to discover whether methods similar to those that had been so successful in the army had any value in our industry.

Among other things, a scheme of executive rating very similar in principle to the army plan for officer rating was developed. This has been continued as a means of foreman rating. There are seven qualifications considered under this scheme, namely: Appearance and manner; technical ability; initiative; leadership; planning ability; cooperative ability; and ability in developing men.

The division superintendents rate each of their foremen and job foremen under this plan every six months. Frequently they ask the general superintendent to make independent ratings as a check upon their own. The foremen are told in a friendly and helpful way just how they fall short of perfection and suggestions are made to them as to ways and means for correcting their weaknesses. When promotions are to be made, the ratings of the candidates have a considerable influence on the choice. The rating scheme is analytical—it reduces the influence of prejudice and is the means of upgrading and developing the foremen by placing their deficiencies frequently before them.

# Tube Bending Fixtures

Devices Employed for Bending Bundy Tubing into a Variety of Shapes

By CHARLES O. HERB

THE small-diameter tubing manufactured at the plant of the Bundy Tubing Co., Detroit, Mich., by the interesting process described in April MACHINERY, can readily be bent into various shapes to suit many applications. It is used extensively on automobiles to carry away the overflow of radiators and to feed gasoline to the carburetors from the supply tanks. Tubes for these applications are bent to shape, on a quantity production basis, by means of hand-operated fixtures, after the tubes have been cut to the desired length from the long pieces delivered by the tube-rolling machine. These fixtures, the more important of which will be described here, are designed along principles that could probably be applied in bending other tubing or piping. Those described are used for bending tubes of 5/16 and 3/8 inch outside diameter.

## Bending Five Tubes at One Time

Five thousand tubes with a double bend are produced per nine-hour day by employing the fixture illustrated in Fig. 1. There are five small-diameter arbors *A* which extend to the front end of pressure bar *B*. Tubes are slid over these arbors until they come in contact with gage *C*, which at the beginning of the operation is close to piece *D* of the fixture. The hinged plates *E* are straightened out in line with the tubes,

and the latter are supported at their outer ends by pins on one of the hinged plates. After the tubes are in place, handle *F* is raised to advance plate *B* slightly, so as to exert a pressure on the tubes at the front ends of the arbors. Bending plate *G* is then lifted and fastened to one of the hinged plates *E* by means of a latch.

Bending of the tubes is accomplished by swinging the handle of plate *G* toward the left to pull the tubes partly off the arbors and around a 2-inch circular grooved bending die that swivels on stud *H*. When this bending has been accomplished, plate *G* is dropped as shown, pressure plate *B* released, and a foot-treadle depressed to move gage *C* for-

ward on the arbors until studs on one part of the gage strike blocks *J* and *K* and cause the front piece of the gage to assume an inclined position. As this piece of the gage is inclined, it advances each tube a short distance relative to the preceding one, going from top to bottom, so that all five tubes can be swung 180 degrees on the arbors at one time. The foot-treadle is then again depressed to advance gage *C*

to the position shown, so as to straighten all tubes in line once more, but with the legs just bent extending toward the right from the arbors.

After pressure plate *B* has been retightened and plate *G* again attached to one of the hinged plates *E*, the second bend is produced in the same way as the first. Plates *B* and *G* are then loosened, and the foot-treadle depressed to advance gage *C* still farther forward and push the tubes to the front ends of the arbors so that they can be easily removed. The small handle at the front of the bench is next operated to return gage *C* into the back position ready for reloading the fixture. The pressure exerted on the tubes by plate *B* eliminates all wrinkles.

## Bending Around Circular Forms

Four bends are made in tubes by means of the two fixtures shown in Fig. 2. The fixture at the right is first used to produce two opposite 90-degree bends,

and then the fixture at the left is employed for producing two slight bends. At the beginning of the operation, handle *A* of the right-hand fixture is swung back to the right about 90 degrees to bring rollers *B* and *C* into such positions that the straight tube can be slid between them and forms *D* and *E*, respectively, and against gage *F*. Before handle *A* is pushed back, the swivel piece on which roller *C* is mounted is brought in contact with stop *G*, which causes the roller to be swung clear of form *E*. A similar arrangement at the back disengages roller *B* from form *D*.

After the tube has been placed in the fixtures as explained, handle *A* is pushed slightly farther toward the rear

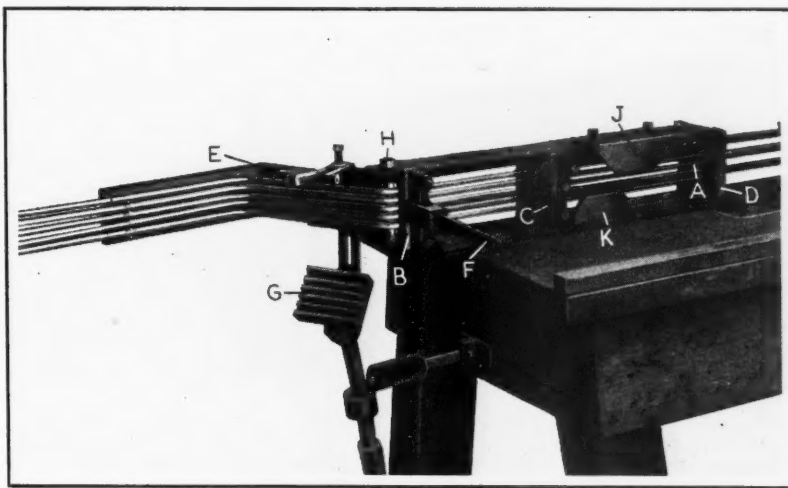


Fig. 1. Fixture employed for bending Five Radiator Overflow Tubes at One Time from Bundy Tubing

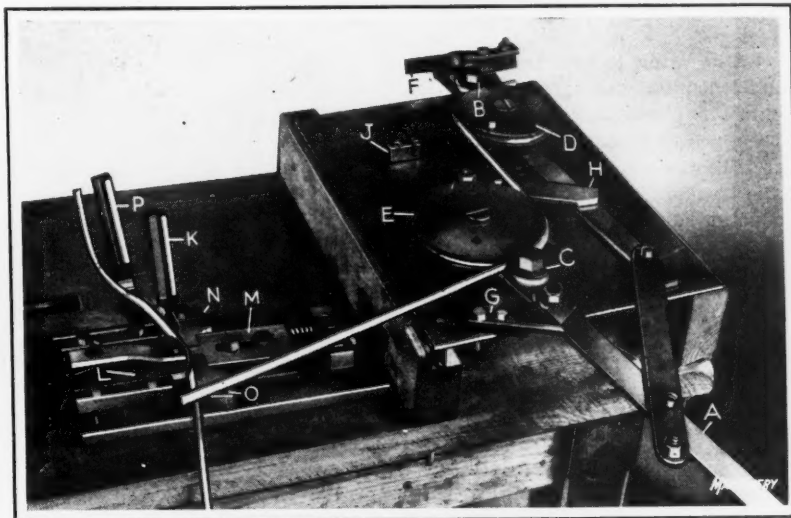


Fig. 2. Two Fixtures which employ Different Principles for producing Four Bends in a Tube

to make the swivel of roller *C* contact with bar *H*. When this occurs, roller *C* is again tightened against the tube and form *E*, and its swivel locked in position on handle *A* for the operation. At the same time the swivel of roller *B* contacts with block *J*, thus forcing that roller against the tube and form *D*. Handle *A* is then pulled forward, and this movement draws roller *B* back along form *D*, and roller *C* forward along form *E* to the positions shown. Two bends of about 90 degrees are formed by the time the swivel of roller *C* again contacts with stop *G* and is disengaged. Bends greater than 90 degrees could be made fully as conveniently by simply shifting the positions of the stops that disengage the two rollers.

The tube is next placed in the left-hand fixture with the short end resting vertically against gage *K* and with the middle straight section of the tube flat in the dies. Then a foot-treadle is depressed to move slide *L* to the right against the tube and piece *M*, which recedes under spring pressure.

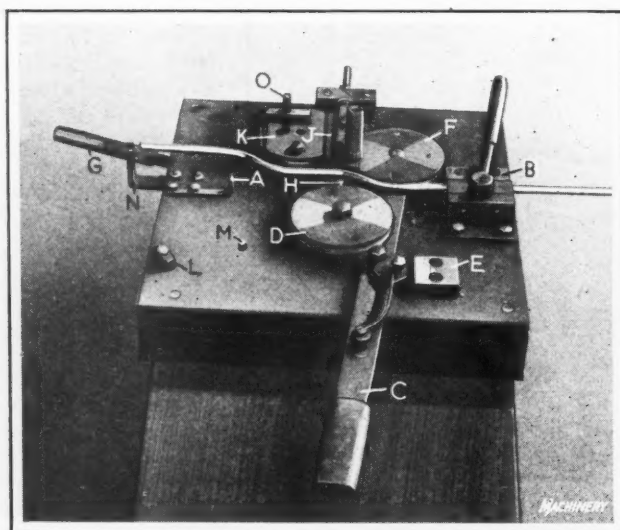


Fig. 3. Producing the First Bends in the Tube completed by Means of the Device illustrated in Fig. 5

The hinged links *N* and *O* also swing to the right, backed up by piece *M*. By the movement of these four pieces, a bend of about 30 to 45 degrees is produced. After pressure on the foot-treadle has been released, the tube is pushed back farther in the fixture with the short end now vertical against gage *P*, and then the treadle is depressed to produce a second bend. The production obtained from these two fixtures is about 5000 pieces per nine-hour day, which is approximately the production of each fixture to be described.

#### Principles of the First and Second Operations Combined

At the right in Fig. 4 is shown a fixture that combines the principles of the fixtures illustrated in Fig. 1 and at the right in Fig. 2. At the beginning of the operation, bending

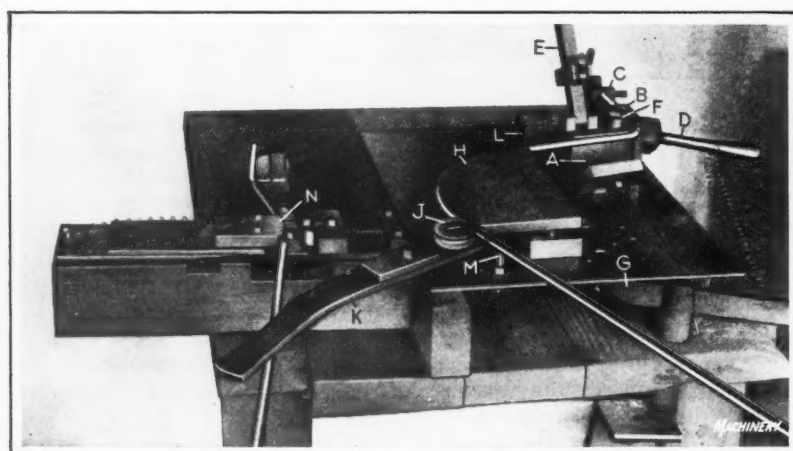


Fig. 4. Tube Bending Fixture having an Automatic Feature

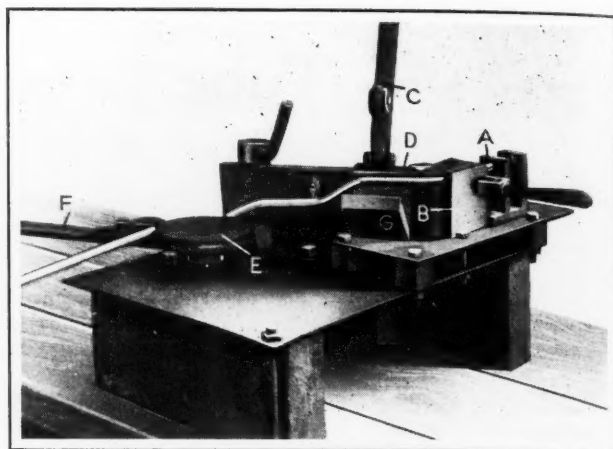


Fig. 5. Bending Device Similar to the One at the Right in Fig. 4

block *A* is swung 90 degrees forward to align it with pressure plate *B*, and then the tube is slipped over an arbor that extends from stop *C* to the forward end of the pressure plate. Handle *D* is next operated to grip the tube, and the hinged cover of block *A* is raised and locked in place by lowering handle *E*. The first part of the operation is now performed by swinging handle *E* and the bending block toward the left, the block swiveling on stud *F*.

As the first step of the operation is completed, bar *G* is automatically operated to raise form *H* and other parts of the second unit into line for the next step. In the meantime, handle *K* with roller *J* has been swung to the rear, so that the portion of the tube projecting toward the left can be placed between the roller and the form. Next handle *K* is

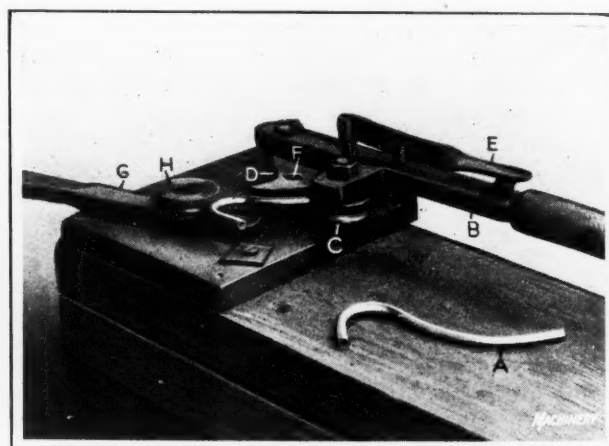


Fig. 6. Ingenious Device used for producing Short Gooseneck Tubes

pushed slightly farther back to make the swivel of roller *J* contact with stop *L*, thus swinging the roller against the form. The tube is then bent around the form by simply pulling handle *K* forward until it contacts with stop *M*. Roller *J* swings automatically away from the form when the handle is returned, and, of course, in the forward movement the pressure of the operation holds it locked against the form. Lever *G* automatically lowers the parts of the second unit when the handle is swung back. The tube is next placed in the bending device *N*, where it is bent by a mechanism identical to that of the left-hand fixture in Fig. 2.

#### Six Bends Made in One Piece

The fixtures shown in Figs. 3 and 5 are used to produce six bends in one tube, four of which are in one plane and the other two at right angles to that plane. The tube is first placed in the fixture shown in Fig. 3, with the front end against gage *A*, and the

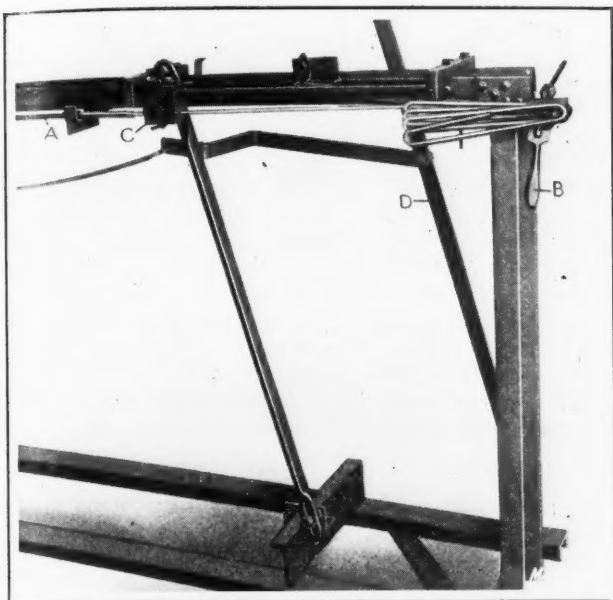


Fig. 7. Equipment by Means of which Tubes 25 Feet Long are formed into Refrigerator Coils

other end held securely by means of clamp *B*. Handle *C* is then pulled to the right until the swivel link to which roller *D* is attached strikes block *E*. This movement causes the link to swivel so that roller *D* grips the tube between it and form *F*. Lever *G* is next operated to lower pin *H*, which holds back the spring-actuated slide *J* when it is raised.

Handle *C* is then swung to the left to bend the tube against form *F*, slide *J*, and form *K*. The slide recedes slightly as roller *D* presses the tube against it. The movement is completed when the handle strikes block *L*, pin *M* being depressed by means of lever *G* to permit this. Handle *C* is now pulled to the right and the tube unclamped, after which it is moved against the second gage *N* and re-clamped. Form *K* is also shifted sideways a short distance and locked in position by means of pin *O*, which is also raised and lowered by operating lever *G*. Slide *J* is moved back by hand between the two steps of this operation.

The fixture illustrated in Fig. 5 is based on the same principles as that illustrated at the right in Fig. 4. The tube, as it comes from the preceding fixture, is slipped over a short arbor attached to block *A* and extending forward through pressure pad *B*. The latter is then clamped in place by means of the handle, and hinged piece *G* of the bending block is clamped to the block proper by lowering handle *C*. Of course, this bending unit is in line with pressure pad *B* at this point of the operation. Handle *C* is then swung toward the left in a horizontal plane to bend the tube somewhat less than 90 degrees.

As the first step of the operation is completed, a roller at the back of the fixture is depressed to operate links that raise the bending form *E* in line with the other end of the tube to be bent. This bend is made by simply pulling handle *F* forward, which carries a roller along the edge of the form in the same manner as described in connection with several of the other fixtures.

The gooseneck tube *A*, Fig. 6, is bent in the fixture shown in the illustration. With handle *B* in about the position indicated, the tube is slipped between roller *C* and form *D*, against a stop at the rear. Then lever *E* is depressed, withdrawing a pin that locks handle *B* in the position shown, and the handle is pulled toward the front until the locking pin automatically enters hole *F* and holds roller *C* in position for the second part of the operation. The large curve of the tube is produced by roller *C* as it is pulled forward. Handle *G* is next pulled forward, causing roller *H* to form the small curve of the tube by pressing it around roller *C*. Even though a small curve is produced in this part, the bend is made without fracturing the tube, and the seam is not required to be placed in any particular location.

#### Forming Long Coils

Refrigerator coils are made from tubes 25 feet long by using the device shown in Fig. 7. The coils vary from 10 to 20 inches in length, and are bent to an inside radius of  $5/16$  inch. For the operation, the tube is supported by a long pipe *A*, into which it is slipped until it reaches a stop at the far end. An arbor fastened at that end of the pipe extends through the tube to the front end of the machine. When the tube is in place, a pressure plate at the front end is clamped on it near the front end of the arbor, and the halves of bending die *B* are fastened together. Then the bending die is swung 180 degrees toward the floor to produce a bend, after which the die halves are unhinged and the pressure pad released. Stock pusher *C* is then gripped on the tube, and handle *D* operated to bring a sufficient amount of tube forward for producing the next bend. The pusher is next returned, and the pressure plate and bending die re-clamped for making the bend. In designing the fixtures described in this article, it has been necessary to allow for "spring back" of the tubes after each operation, a matter of adjustment of stop gages or blocks only.

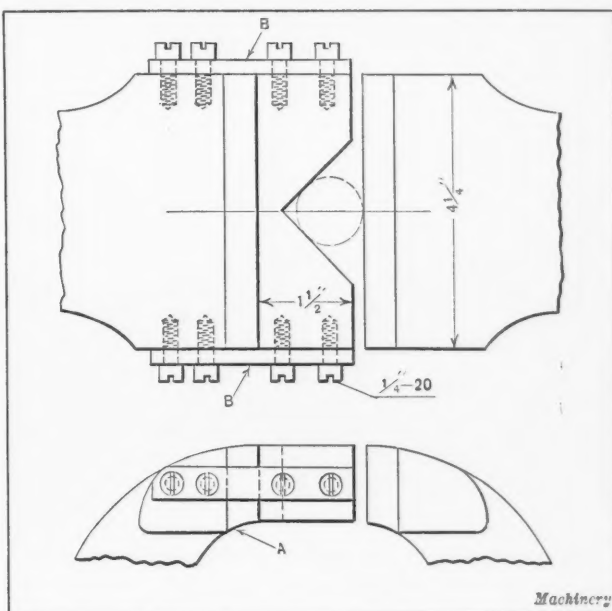
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#### V-BLOCK FOR BENCH VISE JAWS

By ROY A. DRESSLER

The method here illustrated, of equipping the jaws of a vise with a V-block, was originated for the purpose of holding a heated steel part while performing a spiral twisting operation. The steel piece to be twisted was cylindrical in shape and  $1\frac{1}{8}$  inches in diameter. It was held vertically in the vise, and twisted with a large tap wrench which fitted a squared head on the upper end of the part. Before providing the vise with the V-block, considerable trouble was encountered in holding the piece in a vertical position and preventing it from slipping between the jaws. The V-block made it possible to locate the heated piece quickly and clamp it in the vise vertically. Thus the piece could be twisted before it had time to cool off. As it was not intended that the fixture or V-block should remain in the vise permanently, it was designed to be quickly attached or detached without removing the hardened steel face *A*.

The strap pieces *B* were attached to the block with  $1/4$ -inch fillister-head screws, this type being used in preference to flat-head screws, as countersinking would necessitate using heavier stock for the straps. The ends of the straps projecting from the V-block were secured to the vise jaw with fillister-head screws in holes tapped in the jaw in back of the hardened face.



Vise Jaws equipped with V-block

# The Problem of Gear Production\*

By EARLE BUCKINGHAM, Engineer, Niles-Bement-Pond Co., New York

THE problem of gear production is essentially the same as all other production problems. First must be determined what is required, and then suitable methods must be found or developed to produce the required results. Often the exact requirements of the parts or product in question are not fully established until actual production has been under way for some time. This imposes on the production effort the additional burden of determining upon requirements. Such, in brief, has been the history of the production of almost every commodity.

## Better Means for Testing and Inspection are Required

The first essential to satisfactory production is suitable means of measuring the results obtained. We must be able to detect and measure definitely any troublesome errors before we are in a position to correct them. Here again we are at a disadvantage in the production of gears. Many valuable and ingenious testing instruments for measuring the various elements of a gear have been devised; but almost without exception they are more laboratory instruments than everyday shop testing tools. Such laboratory instruments have their place, but production requires testing means that are simple, rapid, and effective. Until we know, however, exactly what conditions on gears need continual watching, we are at some disadvantage when we attempt to evolve such facilities. This is the principal reason why such testing means have not yet made their appearance. Despite this lack of the first essential, production must be maintained. In fact, all production is more or less carried on in spite of inadequate information and equipment, rather than because of complete facilities.

Not knowing exactly what we must produce, we must proceed to consider ways and means for producing it. One thing we do know, however, and that is, on gears very small errors make very large troubles. Small errors in profile or small errors in spacing become very apparent to the ear when the gears are operated under load. In addition, as considerable sliding action exists between the gears, smoothness of profile is essential. Furthermore, as most of the gears used in automotive construction must carry high loads and often withstand considerable abuse, they must be hardened. Thus the production department is called upon to meet a very high degree of precision under the most unfavorable conditions.

## Methods Used for Producing Gears

Many methods of machining gears have been devised. These may be roughly divided into two general classes: First, forming; and second, generating. The forming process is the older, and is represented by form-milling the soft blanks and form-grinding the hardened blanks. To obtain results by this method, involves the difficult tasks of maintaining the proper form on the cutter or grinding wheel, and also of maintaining the tool in the proper position relative to the blanks. The difficulties encountered here led to the development of various generating processes.

The generating processes may be divided into two general types: First, where the generating tool represents the form of the basic rack of the gear system; and, second, where the tool represents one of the gears of the system. Here, as before, the form of the tool is of the utmost importance, but its position in relation to the blank has little influence on the profile of the gear produced except as regards the thickness of the teeth. The hope that a generating process would

eliminate all trouble in the production of gears has never been realized. Generating has eliminated some of the troubles encountered in the forming process, but it has also introduced a few difficulties of its own. A burnishing process has been developed which smooths the profiles of machined gears by crowding them into accurate hardened and ground burnishing gears. This process will make a good gear better, but it will not make a bad gear good.

## Gradual Improvements in Gear Producing Processes

One thing after another has been tried to eliminate or minimize the difficulties of producing good gears. The accuracy of the generating tools was questioned. As a result, these tools are now usually ground on the profile to correct them. Then the distortion in the gears due to hardening came in for scrutiny. As a result of this, machines to finish the profiles by grinding after hardening were introduced.

Refinements cost money. The usual order of the day is to reduce production costs. Sooner or later this must be done. But it is a very difficult thing to refine the methods and reduce the costs at the same time. However, the correct solution, if it is ever arrived at, must do this. This reduction in cost may come from a reduction in the amount of scrap and salvaging charges. It may also come from the eventual development of a manufacturing process that produces better work with less productive effort. It has been done in the case of cylindrical surfaces by the development of cylindrical grinding machines, and a similar development may take place in the production of gears.

## The Prospects of Gear Grinding

The introduction of gear tooth grinding has not yet cured all troubles. In the first place, most of the gear grinding machines are made adjustable. This makes them very flexible as regards the product, a desirable feature in jobbing machines, but not a good feature, in many ways, for production machines. Ease of adjustment makes it possible to correct faults readily, but it also makes it possible to introduce faults just as readily. Simple and rapid testing means are also required.

## The Importance of the Operator

To my mind, the largest part of this production problem, and all production problems, is the human equation. The modern plan of subdivision of labor tends to eliminate all interest on the part of the workman in what he is producing. This plan seems to be a necessary evil under present industrial conditions. In the majority of cases, the amount of skill or technique required of an operator is relatively small. The production of the complex surfaces of gear teeth, however, still requires considerable technique on the part of the operator, if the best results are to be obtained. This is particularly true of the grinding processes. At the present time, as much depends upon the machine operator as upon the machine.

Production methods for gears are still in the course of evolution. The wonder is that such good results have been obtained despite the many handicaps. The subject of gears is receiving very great attention at the present time, but considerable research is necessary before all points can be cleared up. In the meantime, our best course of procedure is to make sure that our designs give us the most favorable conditions that we know of; to make sure that our production equipment is kept in the best shape possible; and to discourage carelessness in the sharpening of tools, mounting, and handling of blanks, etc.

\*Abstract of a paper presented before the Production Meeting of the Society of Automotive Engineers in Cleveland, Ohio, September 15, 1925.

# The British Metal-working Industries

From MACHINERY's Special Correspondent

London, September 14

THE metal-working industries show many hopeful symptoms. Business has not yet picked up after the inevitable lull of the August holidays, but those who are sanguine that the autumn will see a notable advance, can point to the fact that the majority of manufacturing industries find themselves in a much better position, as compared with twelve months ago, and with the exception of one or two slight setbacks the general improvement has been steady. Machine tool manufacturers whose products interest the automobile maker have a rosier outlook, as a result of the remarkable activity in small car manufacture, than those whose machines do not come within the requirements of the automobile shop.

In the Birmingham area, the demand for standard types of machine tools has been much improved for some months, but the last few weeks have seen a substantial strengthening of the position, owing to the increasing demand for special machine tools. Automatic chucking machines, multiple-spindle automatic bar machines, and relieving lathes designed for special purposes are among such special machines. One large machine tool maker in this locality has orders for over 100 special machines, and the majority are needed urgently. For the heavier types of machine tools, the principal demand is from railway shops and rolling stock builders, while portable tools are selling well for use in small machining and drilling operations on large electric generating equipment.

The increase in the use of pressed-steel parts in place of castings, drop-forgings, or stampings in the automobile and other industries is reflected strongly in the shops of press and press tool makers.

In the Manchester district, the belief is held that the home market for machine tools will continue to be subject to strong competition, and that the bulk of orders is likely to come from overseas for some time. In this area the trade in machine tools generally is more fitful than elsewhere, but firms who are in a position to supply special types of machines are obtaining a fair number of orders, chiefly on home account. In the same area makers of boring mills have a fair number of machines on order, and business has improved considerably since the midsummer.

One manufacturer of gear-hobbing machines has a good deal of work in hand, as several branches of engineering, and especially the instrument making section, are making great use of the hobbing process for components for automatic telephones, which are being installed on a very extensive scale; the firm referred to reports that business is increasing and June was the best month for many years. There are some well-known makers of woodworking machinery in the Manchester area, but, generally, reports show that business is slack.

In the machine tool districts in Yorkshire, the business in boring and turning mills, the smaller sizes of planers, punching and shearing machines, gear planers and belt-driven power hammers, shows a tangible improvement for which the Colonies are largely responsible.

In the Glasgow district, the machine tool industry has shown many welcome signs of revival during the summer, but the disturbed condition of labor is restricting buying. Light radial drilling machines are selling fairly well, and from several recent reports, it appears there has been some extensive selling of second-hand lathes and other machines; very good prices were obtained for most of these tools. The more important firms in this locality are receiving just

enough orders to keep their plants going, but prices are elastic and uncertain. The steadiest feature noted is the trade with the Colonies and South America.

## Overseas Trade in Machine Tools

During July the exports of machine tools showed a sharp increase in tonnage, although the increase in value was by no means proportionate, the figures being: Tonnage 1259, and value, £116,769, as compared with 936 tons at £111,982 in June. The tonnage regained the position attained in May, but the values correspond only with the comparatively low figures of twelve months ago. The value per ton of exports during July was £93, a figure that compares unfavorably with £120 in June or £109 in May. Imports in July showed a slight increase in value per ton, reaching £151.

The best overseas customer for British machine tools in July was India, which bought tools to the value of £38,000; Australia was next, with £15,000, followed by France, with £12,000, and Spain, with £10,000. The United States sent us machine tools during July to the value of £37,800, which is approximately the value we sent to India. The only other country to send us a substantial quantity of machine tools was Germany, the value of that country's contribution being £17,000.

## The General Engineering Field

Among general engineers the position remains unchanged. Some sections are quite well off and obtain sufficient work to maintain regularity in output; others show spasmodic activity. The larger firms making rolling stock report a much heavier export this year than last, and the position shows signs of further improvement.

Locomotive builders' prospects are said to be better, orders from home railways are still materializing, and fifteen more passenger locomotives for the Southern railway have been ordered from the North British Locomotive Co., Ltd., in Glasgow. Electrical engineers continue to hold a somewhat enviable position, and have little anxiety for the future. Gas and oil engine and steam engine builders are experiencing a slack time, but structural engineers obtain a fairly steady flow of work. Boiler makers in some districts are very busy indeed, but manufacturers of cranes and elevators report that few orders have been received during the last few weeks.

For textile machinery, Germany is a very good customer, and cash is available for nearly all the German orders. So many Russian textile mills are equipped with British machines that the advantages in favor of extension and replacement orders from this country are very great; the question of credit, however, is a difficult one. It is stated that three large contracts have recently been completed. On the whole, textile plants are in a very good position.

## The Automobile Industry

Automobile manufacturers are experiencing a slight slackening of activity since the seasonal peak was passed, but it is not expected that the lull will be of long duration. Prices having become practically stable, next year's programs can be prepared with a much freer hand than previously. The export trade in automobiles continues to expand in a very satisfactory manner. It is expected that a factory will be built at Liverpool to make Moon cars for the British market; apparently it is intended to build these cars on the same lines as in America, but some of the cars will be fitted with engines of a well-known English make.

## Current Editorial Comment

in the Machine-building and Kindred Industries

### THE AUTOMOBILE SHOP—A TRIBUTE

No one can examine in detail the operations of a large automobile plant without admiration for the remarkable efficiency with which most of these plants are conducted. In the automotive industry, guesswork and haphazard methods practically have been eliminated, and production moves along with a precision that even an efficiency engineer of twenty years ago would not have dreamed of. The spectacle of automobiles assembled with clockwork precision at the rate of one a minute, the completed automobile with a driver in the seat and gasoline in the tank being driven off the assembly ways under its own power, demonstrates the almost unlimited possibilities of modern engineering. The mind apparently is capable of solving almost any problem with which it may be confronted, provided a sufficient number of capable brains concentrate on studying the problem.

The automobile engineer has taught the mechanical world what can be accomplished by mass production. In the face of increased prices in every other industry, the price of automobiles has been reduced, so that a far superior product is now obtainable at a lower price than ten years ago.

Methods similar to those used in automobile production are being applied more and more in the manufacture of numerous other machines and devices in general use, placing within the reach of almost everybody appliances that were luxuries until a few years ago. A safe prediction can be made that ten years from now the domestic washing machine, the automatic household refrigerator, the electric sweeper and many other electrical and mechanical devices will be in as common use in the home as the sewing machine. All this, again, means added activity in the mechanical field and new developments in the machinery industry.

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### USED MACHINERY PROBLEMS

Shall the machine tool manufacturer resell his own line of used machine tools, or shall he leave that business entirely to those who specialize in such machinery? The machine tool industry is giving more and more attention to this question and several manufacturers have bought a considerable number of used machines of their own make in the market, repaired or, if necessary, rebuilt them, and resold them to buyers who prefer used machines because they are cheaper.

One of the largest and best known companies has dealt in used machinery of their own make for about eighteen months and claims to have been very successful. Several advantages are said to have resulted, an important one being that the prices of used machines of this company's make have been maintained at a higher level. Customers for their used tools come to the makers, and the direct contact makes it possible to decide whether they should buy a used machine or a new one. Sometimes the customer's needs would not be satisfactorily met by a used machine, and he buys a new one that is really a better investment.

It has been possible for the department dealing in and rebuilding these machines to pay its own expenses and even make a small profit; but the control of his market that the manufacturer gains if he is able to absorb a fairly large percentage of the better machines of his make that are offered, selling them as occasion arises, is the most important consideration. The policy of the company referred to indicates that in their case progress in the used machinery problem has been made, although the same methods may not be prac-

ticable for every manufacturer, on account of the amount of capital required to carry a reasonably large stock of used machines and to finance an organization for marketing them.

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### BRAINS IN IRON AND STEEL

In the early days of the machine-building industry, equipping a shop and keeping it abreast of the times was a comparatively simple problem. There were few distinct types of machine tools, and both the quantity and quality of the production from these hand-manipulated designs, depended quite largely upon each workman's initiative, energy and skill.

But times and conditions have changed. Now the plan is to do the brain work before the job is started, insuring higher production and uniform quality by greater use of purely mechanical means. So we find in modern shops highly developed machines and special tools which represent brains transmuted into iron and steel. Such equipment, once adjusted and started, is independent of man's skill and energy.

These intensive developments have revolutionized manufacturing practice, and many machines considered good only a few years ago cannot longer be operated profitably. New cost and quality standards have been established, and with them new standards for progressive manufacturers. Machine tool builders are continually placing on the market new designs and types of high-production tools, because proof of their economy to the user has been established by thorough tests under service conditions.

Intelligent competition is hot on the trail of every user of obsolete tools, and there is but one way to keep in the lead: Throw out the old tools and throw off the dead load.

\* \* \*

### DON'T SKIP GOOD ARTICLES

In paging through a technical journal, some readers pass over articles that at first glance do not appear to contain much information of direct value to them; but it actually pays to give a reasonable amount of time to most articles, as many readers tell us. Recently a subscriber wrote that while he usually was not interested in buffing, the articles in MACHINERY on "Automatic Buffing Methods" contained considerable information that he had been able to apply to his work. In designing work-holding chucks for use in an altogether different type of machine, he made use of ideas obtained from the illustrations of chucks employed in buffing operations described in the articles mentioned.

Another subscriber employed in one of the large railroad shops read in MACHINERY the description of a fixture used in milling several automobile connecting-rods at one time, and decided that a much larger fixture based on the same principles would facilitate the machining of locomotive connecting-rods. This he designed and it is now in daily use, effecting substantial economies. Days might have been spent in developing a design not nearly so efficient as the one this reader was able to adapt, and if he had skipped the article, the operation probably would still be performed in the old way.

Innumerable savings in operations are directly traceable to the willingness of some men to spend a few minutes on articles that others engaged in similar work consider of no value to them.

# Commercial Cylindrical Lapping\*

By C. T. APPLETON, Reed-Prentice Co., Worcester, Mass.

LAPPING is a means of obtaining a good bearing surface on parts prior to using the parts. The engineers of one of our largest automobile factories state that lapping adds ten thousand miles to the life of piston-pins. The introduction of the "Mirra" cylindrical lapping machine (described in August, 1924, MACHINERY, page 990) provided a method of cylindrical lapping on a production basis.

Lapping Automobile  
Piston-pins

In lapping automobile piston-pins in this machine, the pins are placed loosely on a quick-loading work-spider, as shown in Fig. 1, which is located between two horizontal lapping wheels. The wheels rotate in opposite directions at slightly different speeds. In the operation, the upper wheel is brought down on the piston-pins under pressure, and the variation in the wheel speeds causes the pins to rotate and creep slowly in a circular path in the direction of the faster wheel.

The projecting arms on the work-spider are not radial relative to the center of the spider; this causes the piston-pins, while rotating, also to have a sliding action between the wheels. The spider rotates eccentrically in relation to the wheels, and this gives the pins an in-and-out sliding action. Hence, the work has the following distinct actions between the wheels:

- 1. Creeping, caused by the variation in wheel speeds.
- 2. A sliding rotating action, caused by the work being set at an angle to the center of the wheels, instead of radially.
- 3. An in-and-out sliding action from the center of the wheels, due to the eccentric spider motion.

For production purposes at least two machines are used regularly, one for rough-lapping and one for finish-lapping. However, where small production will not warrant the use of two machines, one machine may be used, equipped with a pair of roughing wheels, complete with flanges, and a pair of finishing wheels, complete with flanges. When two machines are used, a spider full of pins taken from the rough-lapping machine is passed directly to the finishing machine. This condition permits the pins rough-lapped to the same diameter to be passed to the finishing machine without removing them from the spider.

A typical method of making piston-pins consists of machining the hole and ends complete in an automatic screw machine, heat-treating,

\*Abstract of a paper presented before the Machine Shop Practice Division of the American Society of Mechanical Engineers, at New Haven, Conn., September 10, 1925.

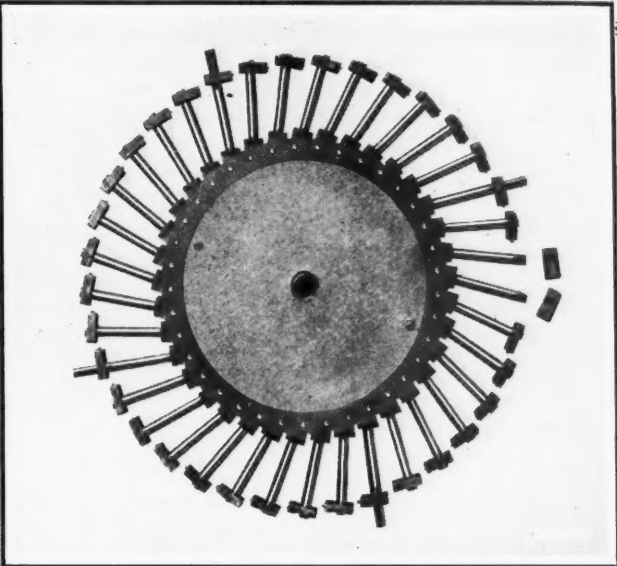


Fig. 1. Spider used for holding Automobile Piston-pins while lapping

rough-grinding in a centerless grinder, finish-grinding in the same type of machine, rough-lapping in the "Mirra" cylindrical lapping machine, and finish-lapping in the same machine. Three cuts are taken in rough-grinding and two in finish-grinding. At the end of the finish-grinding, 0.0005 inch of stock is left to be removed by lapping; 0.0004 inch of this stock is removed in rough-lapping, and the remaining 0.0001 inch in finish-lapping.

Limits Allowed on Lapped  
Work

The limits usually allowed on finish-lapped pieces are as follows: Roundness, within

0.0001 inch; taper, within 0.0002 inch; and diameter, from 0.0002 to 0.0005 inch. It may be stated that out-of-roundness of work produced in the "Mirra" machine is negligible and that the diameter and taper can easily be kept true within 0.0002 inch. With special care on the part of the operator, the diameter can be kept within 0.0001 inch.

It is the standard practice of the Reed-Prentice Co. to allow from 0.0004 to 0.0005 inch of stock to be removed from the diameter in rough-lapping, and not more than 0.0001 inch in finish-lapping. The finish-grinding diameter is usually left over-size by the amount of stock to be removed in rough-lapping, plus the tolerance obtainable in grinding. For example, if a piece were to be finish-lapped to 1 inch within minus 0.0000 inch and plus 0.0002 inch, the maximum finish-lapped diameter would be 1.0002 inches; the amount of stock to be removed in rough-lapping, 0.0004 inch; and the minimum finish-ground diameter, 1.0006 inches.

Therefore, with a finish-grinding allowance of 0.0002 inch, the finish-ground sizes range from 1.0006 to 1.0008 inches, necessitating the removal of from 0.0004 to 0.0006 inch of stock in lapping. The piece, after being rough-lapped, would be at the high limit of the finish-lapping; therefore, from 0.00005 to 0.0001 inch of stock would be removed in finish-lapping to bring the piece within the tolerance.

The lapping time in production is about the same for the roughing and finishing operations. In the accompanying

table are given conservative production figures obtained in lapping piston-pins of different diameters and lengths, either rough or finished. The same figures would also apply to other cylindrical work of a similar nature.

When two machines are used, one for rough-lapping and the other for finish-lapping, the average output of finished pins per hour would be in accordance with the table. In order to reduce the idle time of the machines to a minimum, it is customary to have from six to eight

NUMBER OF PISTON-PINS LAPPED PER HOUR

Diameter of Work, Inches	Maximum Length of Work, Inches				
	1	2	3	4	5
3/8	1340	1226	1095	980	862
1/2	1155	1050	950	847	730
5/8	1010	920	823	730	643
3/4	890	818	730	657	569
7/8	....	730	657	585	512
1	....	672	598	540	567
1 1/8	....	614	556	496	423
1 1/4	....	569	512	453	395
1 3/8	....	526	467	424	365
1 1/2	....	496	438	394	351
1 3/4	....	....	395	336	307
2	....	....	351	307	278

Machinery

work-spiders, one operator for each machine, and a helper to load the work on the spiders.

### Method of Truing the Lapping Wheel

For rough-lapping, a medium grain, soft grade of emery wheel is used, while for finish-lapping, the very finest grain and softest grade of wheel is used. The lower wheel is rigidly mounted on its spindle, while the upper wheel has a floating action. This floating action permits the upper wheel to locate itself parallel with the work and the cutting surface of the lower wheel. In truing either wheel, it is, of course, necessary that both wheels be rigid. The truing arm is arranged with two independently operated diamonds, one for the upper wheel and one for the lower. The upper diamond is adjusted by means of a knurled collar until it just comes in contact with the upper wheel, and it is then fed back and forth across the wheel by the use of the truing-arm handwheel.

The lower wheel is trued in an identical manner, and in order to keep the wear of the wheels at a minimum, as light a cut as possible is taken by the diamond. Under average

The following are variable factors: Eccentricity of work-spider; speed of wheels; pressure of wheels on work; grade and grain of wheel; and time.

### Wheel Pressure on the Work

For determining the effect of the wheel pressure on the work, all conditions were kept constant with the exception of the pressure and time. In obtaining the pressure, the upper wheel was arranged with a moment arm in place of the pilot handwheel. Connecting the outer end of this arm to the floor was a spring balance arrangement, which gave a means of applying variable pressures of the upper wheel on the work. To obtain an exact direct wheel pressure from the spring balance arrangement, a pressure scale was placed under the upper wheel.

This procedure took into consideration the mechanical friction encountered in the machine, and the weight of the wheel was recorded separately, so that as the cutting surface was trued from time to time, the reduction in the weight of the wheel was known. The results of this experiment are shown by the curves in Fig. 2. Curve A shows the relation

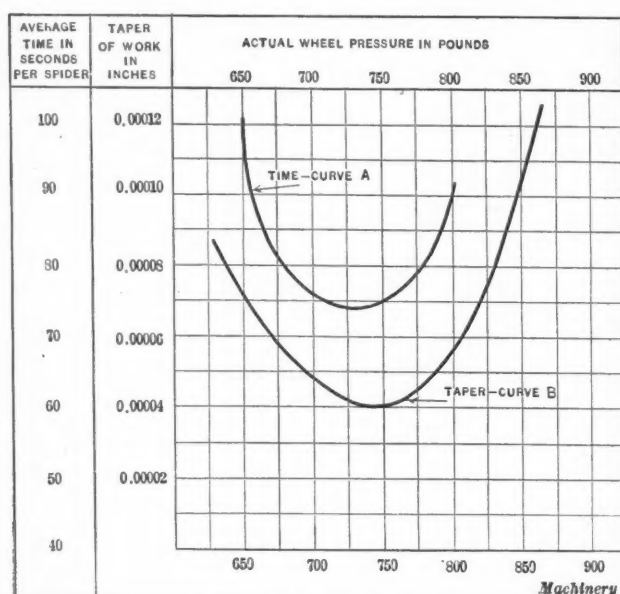


Fig. 2. Diagram showing the Effect of changing the Pressure of the Upper Wheel on the Work

conditions, it is only necessary to true the wheels about every 3000 to 5000 pins. It is of advantage occasionally to dress the wheels by simply passing a dresser back and forth over the cutting surfaces by hand. After truing, the wheels are washed and thoroughly cleaned from all loose emery.

### Compound of Water and Oakite

It has been found most satisfactory to use a compound of water and oakite when lapping, the ratio being one pound of oakite to ten gallons of water. This solution keeps the wheels and work clean, and also prevents rusting. It may be said that this process of lapping is absolutely clean from emery, so that there is no possibility of emery getting into the bearings in which the finished lapped parts are used.

### Experiments Made to Place Lapping on a Scientific Basis

Lapping is an art, but through this machine the Reed-Prentice Co. is endeavoring to place it on a scientific basis. To do this, it is first necessary to determine the effect of each varying factor in a lapping operation, to study each separately, and then, after finding the effect of each, make a separate analysis for the effect of each on the whole. In making a careful study, the following may be considered as constant factors: Amount of stock removed; work; dressing of wheel-cutting surface; truing of wheel-cutting surface; cutting compound; number of pieces on work-spider; and number of pieces lapped.

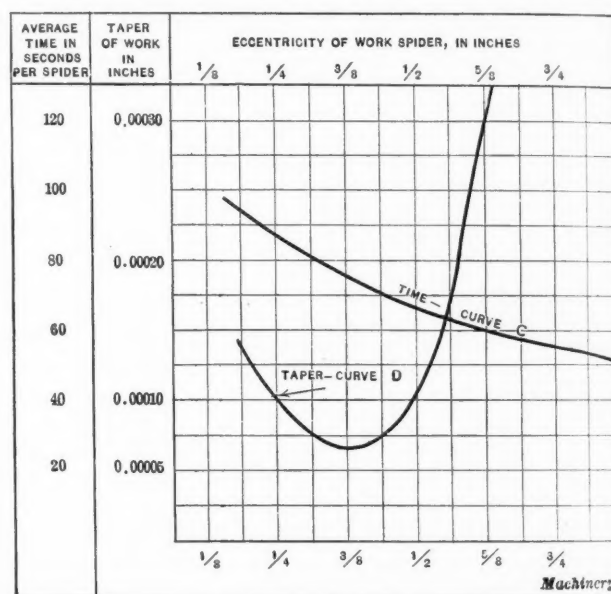


Fig. 3. Diagram showing the Results of changing the Eccentricity of the Work-spider

of time to wheel pressure. The curve shows that the time decreases with an increase of pressure up to a pressure of about 725 pounds, and from there on increases in approximately the same manner. From curve B, it is interesting to note that the pressure has approximately the same effect on the tapering of the work as it has on the time. Both curves have approximately the same shape, thereby showing that it is important to have the correct pressure of the upper wheel on the work to obtain the most satisfactory results.

### Eccentricity of the Work-spider

To determine the effect of varying the eccentricity of the work-spider, all elements, with the exception of the eccentricity and time, were kept constant. Several experiments were made with the eccentric pin located in different positions. The results of this test are shown by the curves in Fig. 3. From curve C it will be noted that the time decreases with an increase of the eccentric movement of the work-spider, showing that the greater the eccentricity, within certain limits, the faster the stock is lapped from the pins.

Curve D illustrates the tapering effect on the work with a variation in eccentricity. With an increase of eccentricity up to 3/8 inch the amount of taper decreases, but with higher eccentricity, the taper increases at an extremely rapid rate. In comparing curves C and D, it will be appreciated that the taper curve D is the controlling factor, as

the accuracy of the parts produced is more important than the rate of production. Therefore, the most satisfactory amount of eccentricity under the average conditions would be approximately 3/8 inch.

From the tests made thus far, to determine the effect of varying the speed of the wheels, it is impossible to give a satisfactory set of curves. However, it will be stated that the best results have been obtained with a mean wheel speed for the upper wheel of 180 feet per minute, and for the lower wheel, of 220 feet per minute. The rolling effect on the work averages approximately 300 feet per minute.

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### ACTIVITIES OF THE S. A. E.

Rapid progress in the development of the motor vehicle during the last twenty years, the low prices of cars, and the enormous number in use are due in great measure to the cooperation of engineers and their interchange of knowledge and ideas through the Society of Automotive Engineers (S. A. E.). A saving of at least 15 per cent in the total annual retail value of American automotive products is estimated to have been effected by the standardization work that has been done by the society. The effects are evident in the manufacturing, servicing, and use of cars and trucks. To form only the slightest idea of the value of this work, it is necessary only to imagine the conditions if spark-plugs were not standardized as to diameter and thread and there were perhaps fifty or more different sizes on the market.

Organized in 1905, the S. A. E. took over the work of automobile standardization which had been inaugurated by the National Association of Automobile Manufacturers in 1900 and continued and expanded by the Association of Licensed Automobile Manufacturers. About six years later, the Society of Aeronautic Engineers and the Society of Tractor Engineers were merged with the Society of Automobile Engineers, and the last-named organization changed its name from "Automobile" to "Automotive" and became active in standardization in aeronautic and tractor engineering. Subsequently, the National Association of Engine & Boat Manufacturers and the National Gas Engine Association took action whereby the S. A. E. also became active in standardization in the motor-boat and internal-combustion engineering fields.

More than 600 standards and recommended practices have been approved by the Society of Automotive Engineers up to the present time. Standardization work is now in progress on more than 60 subjects relating to passenger car bodies, motor trucks, motor boats, agricultural power equipment, engines, ball and roller bearings, electrical equipment, lighting, iron and steel, lubricants, parts and fittings, springs, and screw threads. The society has twenty-eight standardization divisions, and cooperates with twenty-seven national organizations and six government departments through the American Engineering Standards Committee.

The S. A. E. maintains a very active research department, which last year investigated the major subjects of fuels, highways, and riding qualities, and answered more than 1000 inquiries. It is now making plans to devote more attention to aviation and motor-boat engineering than ever before, and plans are also being prepared for extending its facilities more effectually to students who are taking engineering courses in colleges and universities. From a membership of 400 at the end of 1909, the society has grown to a membership of 5500, including nearly 100 foreign members.

\* \* \*

Recent information from Germany indicates that during the last few months the export trade in the machinery field has fallen off considerably. Of the total orders now in the hands of the German engineering industry, not more than 20 per cent are export orders, whereas during preceding years, this figure has been from 25 to 30 per cent. The fields suffering particularly are those engaged in the manufacture of engines, machine tools and mining, smelting, and rolling mill machinery.

### MACHINE TOOL NEEDS OF THE AUTOMOTIVE INDUSTRY\*

By R. M. HIDEY, White Motor Co., Cleveland, Ohio

Development in the machine tool industry started with the advent of the steam engine, and for a time was closely associated with steam engine development. For a long time, activities were confined mostly to perfecting existing machines, and there was no further striking development until the automotive industry began to make demands for interchangeable manufacturing which the existing tools could not meet.

The demands of the automotive industry have given an unparalleled impetus to and have been responsible for most of the development in the machine tool industry during the last fifteen years. This has been due to rapid automotive engineering developments and keen competition, fostered by public demand for better and cheaper transportation. Without the assistance of the machine tool industry, the automotive industry would never have reached its present stage of development. In fact, the friendly cooperation which has existed between the two industries is responsible for the success of both.

#### Single-purpose versus Multi-purpose Machines

A question that is causing considerable concern to many equipment engineers is the advisability of using single- or multi-purpose machines. Originally machines capable of handling a wide variety of work were used, and then when these machines were used only as single-purpose machines, a considerable investment remained idle. Those machines that are of a strictly single-purpose character are economical only when production is reckoned in thousands per week. The most general demand is for machines that are especially suitable for high production but that can be readily adapted, by changes in tool equipment, for making similar parts of another model or even for performing other work.

There has been too much attention paid by the machine tool industry to single-purpose machines which satisfy the demands of only those concerned with large production of a limited line. However, there is a real demand in the automotive industry for multi-purpose machines, as, with frequently varying production demands, it is at times decidedly advantageous to be able easily to change jobs from one machine to another, to another department or even to another plant. Standardized machines fitted with special tools for the performance of a variety of jobs should be cheaper to build and operate, and would be a source of profit to the machine tool builders and to the automotive manufacturer.

#### Advantages of Standardized Machines

A standardized line of machines offers the following sales arguments: Lower initial cost, remoter risk of obsolescence, and higher second-hand value. It would also be possible for the user to maintain a supply of repair parts, resulting in the elimination of expensive machine repair departments, and enabling repairs to be made promptly.

The multi-purpose machine is particularly valuable in the small shop, the service machining departments of automotive factories, and in automotive service stations, which number seventy thousand in this country. This combined field is of tremendous size, and consequently permits of complete standardization, with its resulting economies both for the builder and the user. Standardization of this type of equipment is attempted by all large manufacturers operating branch service stations.

#### Safeguarding Machine Tools

The failure of machine tool builders adequately to equip machines with safety guards increases installation costs to an unnecessary extent. It is necessary at the White Motor Co. to spend from \$20 to \$75 in order to make new machines

\*Abstract of paper presented before the Production Meeting of the Society of Automotive Engineers in Cleveland, Ohio, September 15, 1925.

safe to operate. The builders of machines should be able to equip their machines more satisfactorily and cheaply with safety guards than the customer, as a standardized practice could be followed for their individual product. The result would be that all machines would be properly guarded, with a decided economic saving.

Under existing laws, it is possible for machine tool builders to sell machines in Ohio that, in the same unguarded condition, could not be sold in New York state. The automotive industry, being the largest user of machine tools, is thus called upon to spend large sums of money in guarding machines, as it is generally demanded that machines should be guarded for safety rather than merely to conform to the law. A more general application and standardization of guards would greatly reduce the customer's burden.

#### Cooperation Between Machine Tool Builders is Needed

Considerable stress has been laid upon the need for cooperation between the machine tool builders and the automotive industry. The possibilities of this cooperation, however, are only beginning to be realized. A fact that we in the automotive industry are peculiarly fitted to recognize is that there has been considerably more cooperation between machine tool builders and their customers than there has been between the machine tool builders themselves.

Manufacturers in the automotive field freely give information to competitors and permit full access to their factories, with the exception of their research and experimental departments. A high degree of cooperation thus exists which often results in the solution of difficult problems and the perfection of processes.

This cooperative spirit does not exist in the machine tool industry. However much the individual builders have cooperated with the automotive industry, they themselves have not come together with a comparable spirit for the working out of mutual problems. The desire to excel has predominated, to the exclusion of the cooperative spirit, which would have resulted in stabilizing the machine tool industry.

#### Research Would Aid Development of Machine Tool Industry

The natural development of the machine tool industry has actually been retarded because cooperation has been confined principally to the users of the product. The machine tool industry is entirely too dependent on its customers for new ideas and applications, whereas it should be the leader in the industrial field. The designing phase of machine tools should be given the same careful study that the automotive field has given to its problems, thus creating a wider field for its product. Progressive automobile manufacturers have to forecast to an extreme degree of accuracy the number of vehicles they can sell for months ahead, and also whether their customers will want power, economy, safety, or speed. The design, research, and experimental departments thus have to be considerably in advance of actual production.

#### Machines Should be Carefully Tried out Before Delivery

In machine tool development, the testing out—a burden which should properly be borne by the builder—has been thrown upon the buyer. Generally the builder calculates a certain performance of a machine which he places upon the market; and, after the machine is delivered, from a few days to several months is spent in trying to secure that performance. The White Motor Co. recently purchased a machine and, failing to obtain the guaranteed performance, called for the builder's demonstrator. He remained at the plant for several months before results were attained. This is a situation for which the machine tool builder should assume a definite responsibility instead of passing it on to the customer.

#### Need of Machine Tool Standardization

It is gratifying to note that the committee working under the auspices of the American Society of Mechanical Engineers and the National Machine Tool Builders' Association

has made considerable progress in the standardization of T-slots, which should save thousands of dollars for the industry. The automotive manufacturers would be pleased to see standardization worked out for such features as spindle noses, internal and external turret holes, lead-screws, working heights, and standard machine data sheets. A manufacturer who has a large diversity of machines of a similar make would be able to reduce his costs appreciably, if such features were standardized.

#### Importance of Balancing Moving Machine Tool Parts

The balancing of moving parts has been almost entirely neglected by machine tool builders. The vibration of moving parts such as gears, wheels, and shafts, which are seldom balanced, is frequently excessive, and materially decreases the life of the machine. This could well supplement the other standardization recommended.

#### Summary of the Needs of the Automotive Industry

In summarizing what the automotive industry needs in the way of machine tools, the following specific recommendations may be made to machine tool builders:

1. Develop multi-purpose machines capable of using special tool equipment that is adapted for quick change-overs.
2. Safeguard all machines, so that they can be put into immediate operation without extra expense to the customer.
3. Balance all moving parts properly so that vibration will be reduced to a minimum.
4. Continue cooperating with the automotive industry, and begin to cooperate actively with each other. The free interchange of new ideas and developments would be of infinite value to industry as a whole.
5. Study the demands of the market, analyze the needs of the automotive industry, not only for today, but for the future.

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#### SIX- AND EIGHT-WHEEL VEHICLES COMING

There are almost unlimited opportunities in the field of transportation for the use of six-wheel and eight-wheel motor vehicles, said A. F. Masury, vice-president and chief engineer of the International Motor Co., in an address before a meeting of the Metropolitan section of the Society of Automotive Engineers in New York City. Present types of motor vehicles are serving present needs in a more or less successful way, he said, but when strict economies become an essential feature of road transportation, a demand will be made for vehicles that will accommodate the maximum loads in the minimum of street space. These vehicles must be designed so as to permit speeds commensurate with common sense and safety. They will offer the utmost in passenger comfort and will prove of great value in hauling perishable goods over long distances in quantities large enough to assure strictly economic operation. Six- and eight-wheel coaches already have seen a great amount of service in California.

Last October Mr. Masury's own company completed a six-wheel motor coach of the most advanced type which has since traveled many thousand miles in tests. It has two driving axles at the rear, 50 inches apart, the forward one of which is 241 inches back of the front axle. The over-all length of the chassis, including bumpers, is 35 feet, yet it can turn on a 36 1/2-foot radius to the right and on 44-foot radius to the left, and it has been driven through the narrow traffic-congested streets in New York, Newark, and Boston during rush hours. The top of the chassis frame is only 21 inches above the road surface. It is driven by a 100-horsepower six-cylinder engine, and has a four-speed transmission. All four rear wheels are driven, which gives a very good traction and prevents skidding.

\* \* \*

Automobile insurance rates for 1925 were fixed on a basis of 30,000 deaths in approximately 1,000,000 motor vehicle accidents. The rates can be reduced by decreasing the number of accidents.

# The Foreign Trade Outlook in the Machine Tool Field\*

By W. H. RASTALL, Chief of Industrial Machinery Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.

**F**ORTUNATELY, information is now available that makes it possible to derive a reasonably clear idea as to the future prospects of American machine tool exports, a thing that has not been possible for about ten years. In order that we may have a clear understanding of the situation, it is desirable to review the experience in this trade since about 1910.

In pre-war years the metal-working machinery export trade was very important and was expanding rapidly, and although Canada, Japan, Brazil, Argentina, and Mexico took important quantities of machine tools, by far the larger proportion of these shipments went to Europe—some 75 to 80 per cent of the total. The volume rose steadily from about \$3,600,000 in 1909 to a total in excess of \$16,000,000 in 1913, giving an average for the five pre-war years of a little less than \$10,000,000 a year of which Germany absorbed \$2,300,000; England, \$2,000,000; France, \$1,000,000; Canada, \$1,000,000; and the other countries smaller totals.

With the outbreak of the war, there was a sharp increase in the European demand for equipment of this kind, and by 1917, the total had expanded to about \$85,000,000, over eight times the pre-war average. This export demand was in addition to a very heavy domestic demand. When the United States entered the war, certain embargoes were imposed that had the effect of decreasing the export volume, which in 1918 was only slightly in excess of \$50,000,000. In 1919, following the armistice, this total expanded to about \$58,000,000 and then with the collapse of the post-armistice boom, exports fell off rapidly until 1922, when the total approximated only \$13,000,000, of which Europe absorbed only 32 per cent, and Asia, which in pre-war years had usually absorbed less than 2 per cent, was now taking 35 per cent of the total.

## The Machinery Exports to Asia

This demand from Asia for metal-working machinery represents a most interesting development there, because practically every Asiatic country is ambitious to become industrialized. In traveling these countries, one gathers the impression that those people realize that the high standard of living of the United States is made possible by the industries established here and the machinery employed in those industries. Conditions resulting from the war released a large amount of capital in many of these countries, and as a consequence, there was a great industrial boom which was felt throughout Asia.

India, as an example, absorbed far more factory machinery in the few years following the armistice than in her entire previous history. China showed somewhat similar results, and Japan has long been distinguished for the employment of the best types of machinery. However, like other booms, it appears that these new industries have not always been successful, and there is now in progress in many Asiatic countries what might be called a period of assimilation. One must not infer from these statements that industry there is really depressed, because even now the machinery imports of these Asiatic markets are greatly in excess of the volume taken in pre-war years.

## The European Machine Tool Markets

The markets of Europe, following the armistice, were greatly overstocked with metal-working machinery, with the result that since 1918, it has been very difficult to sell additional metal-working machinery in those markets. However, it is gratifying to be able to report that apparently a position of reasonable stability has now been reached, and the volume of metal-working machinery shipped into Europe from the United States has risen consistently from about \$4,000,000 in 1922 to, roughly, \$5,000,000 in 1923, reaching a total in excess of \$7,000,000 in 1924. Returns for the first six months of 1925 indicate a further rapid expansion.

Latin America, also, is rapidly demonstrating its importance as a market for American equipment. It is in this area that we feel the strongest competition from European manufacturers. The Latin American countries took only 5 per cent of our total exports in 1913 but in 1922, 1923, and 1924, the participation approximated 14 per cent. The demand from Canada also indicates a substantial and growing market for American equipment.

## What May be Expected in Japan, India, and China

It is even more interesting to consider the experience in individual countries, because this provides a guide as to the sales policies that should be adopted by our exporters of metal-working machinery. Considering first the markets of Asia, and comparing our pre-war experience with that of the last three years, it will be seen that Japan which ranks third in importance among all of our foreign markets for metal-working machinery, is absorbing rapidly increasing quantities of American equipment. In spite of very unfavorable conditions in the country, the business has shown steady growth. In 1924, Japan took nearly twenty times the volume of American metal-working machinery that was absorbed there in 1913.

British India is another very important market which is not adequately cultivated, but in 1922, it absorbed \$2,400,000

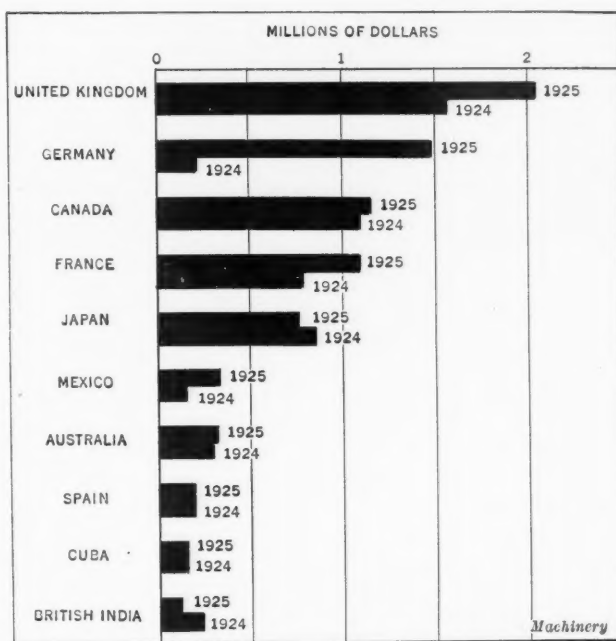


Chart showing Comparative Value of Metal-working Machinery Exports from the United States to Various Countries in 1924 and 1925

\*Abstract of a paper presented before the Machine Shop Practice Division of the American Society of Mechanical Engineers, at New Haven, Conn., September 9.

worth of American metal-working machinery as compared with only \$44,000 in 1913. In other words, in 1922 India absorbed sixty times the value of this machinery that it absorbed in 1913. Unfortunately, this trade with India is falling off rapidly, and in 1924, the total was only \$336,000. Even on this basis, it was eight times the 1913 total. These figures indicate the importance of giving more careful attention to this market.

Similarly, conditions in China have been very unfavorable. Political and financial difficulties of many kinds have developed. However, in spite of this fact, China absorbed, in 1922, probably twenty times as much American machine tool equipment as in 1913, and even in 1924, in the face of disturbed conditions, China absorbed a total greatly in excess of the pre-war level.

A constructive sales policy would indicate that our manufacturers of the simpler types of metal-working machinery would be well advised if they gave more careful attention to the markets of Asia, and, in a general way, these remarks also apply to various South American countries. Mexico,

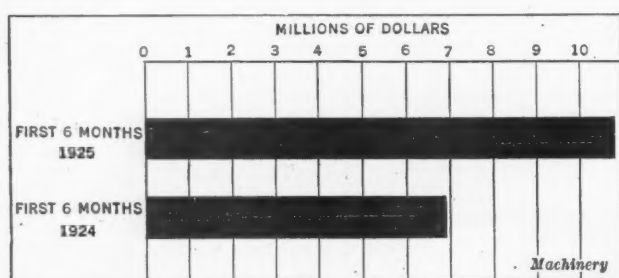


Chart showing Total Value of Exports of Metal-working Machinery from the United States in the First Six Months of 1924 and 1925

Cuba, Argentina, Chile, and Peru are all absorbing a much larger volume of American machine tools than in pre-war years. Brazil is the only market that seems to be falling off, and there are reasons to believe that this situation will correct itself as soon as general business conditions in that country improve.

#### A Review of the German Market Prospects

The situation in Europe, however, is far more interesting, and it is in these markets that our manufacturers of highly specialized production equipment find their best possibilities. In pre-war years, Germany ranked first absorbing more American metal-working machinery than any other country. This trade approximated \$2,250,000 a year. Obviously, all of this was interrupted by the war. Lately, however, there has been a rapid increase in the volume of business, and throughout the latter part of 1924 and up to the present, there has been a rapidly increasing number of orders from German sources. Shipments to Germany rose from \$77,000 in 1922, to \$209,000 in 1923, to \$545,000 in 1924; and for the first half of 1925 the total approximates \$1,500,000 or, say, seven times the volume of business executed in the corresponding months of last year. When one considers the nature of the competition our manufacturers experience in the world's markets from German sources, this record is remarkable.

#### Exports to Great Britain

In pre-war years, England ranked next to Germany as a buyer of American metal-working machinery, and there has been a steady absorption of American machinery of this kind in that market for a great many years. As compared with a pre-war average of about \$2,000,000 a year, England, alone, absorbed nearly \$20,000,000 worth in 1916, and the volume shipped there continued to be very large throughout the war and the post-armistice boom. The low point in this trade was reached in 1922, when the shipments to the United Kingdom approximated \$2,000,000, which, in turn, expanded to \$2,400,000 in 1923, and to \$3,100,000 in 1924. Records of the first half of 1925 indicates a trade about 30 per cent in excess of the shipments made in the corresponding period

last year. When it is remembered that British machine tools are perhaps the most serious competitors of American equipment in the world's markets, these returns also afford a striking testimonial to the merits of the American product.

For reasons that require little comment, the trade with Russia, Belgium, Holland, and Sweden has shown some decrease, but considering the volume shipped to the United Kingdom, France, Spain, and allowing for the conditions in Germany, Russia and elsewhere, it would seem that the markets of Europe have shown a very gratifying recovery. It seems that the time has come when conditions justify more careful sales work on behalf of American machinery in all of these markets, and the prospects for our trade depend not so much upon political and other conditions as upon the energy with which our products are represented there.

Too often, American machinery is not sold, but rather sells itself, and while there are a few American manufacturers who have developed carefully executed plans for sales effort throughout the world, too many others have failed to take full advantage of their opportunities in this respect. Some manufacturers' export ratio is negligible, while others manage to export from 25 to 60 per cent of their production.

#### Increased Sales Efforts will Bring Results

The really big thing lying before us in connection with the foreign trade outlook in the machine tool field is not so much the condition of the various foreign markets, for many of these really need American equipment; nor is it a matter of foreign competition, for most often American equipment is superior to that offered from abroad—a statement supported largely by the shipments constantly being made from this country into England and Germany. The big problem lies in the sales effort made on behalf of American equipment in all foreign markets. It is suggested that our manufacturers would be well advised to review once more their plans for sales effort in foreign markets, in order to see if it is not possible to place the American industry, both as represented by the individual plants and collectively, on a better basis in all foreign countries.

The Department of Commerce in Washington will be glad to cooperate in the solution of any of these problems. There are as many solutions as there are producers and markets, but one plan that has been creating great interest recently has been the suggestion that non-competing manufacturers form groups for collective sales effort abroad, trying in so far as is practicable to place their agencies in the various countries with the same dealers, in order that the collective effort of the group may be stronger than would be possible if each manufacturer were to try to carry his program out alone.

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#### COMING MEETINGS OF THE S. A. E.

Three national meetings of the Society of Automotive Engineers are being arranged for this autumn. The first is the aeronautic meeting, to be held October 7, at the Hotel Astor, New York, the day before the start of the Pulitzer Prize airplane race meet at Mitchel Field, Long Island. Two technical sessions are being planned, one for the afternoon and the other for the evening, with an aeronautic dinner between. One session will deal with aircraft design and construction, and the other with operation.

The annual automotive transportation meeting of the society is to be held November 12 and 13, in the Benjamin Franklin Hotel, Philadelphia. The technical sessions will be devoted to standardization, freight handling, store door delivery, car consolidation, motor coaches, and gasoline-electric drive developments.

Some time in November, also, the service engineering meeting of the society is to be held in cooperation with the National Automobile Chamber of Commerce, as heretofore. The place and dates of this meeting have not yet been decided but two technical sessions are planned as the S. A. E. part of the program. Further information may be obtained from the Society's headquarters, 29 W. 39th St., New York.

# The Application of Friction Clutches to Machine Tool Drives

By S. H. SIMON, Vice-president and General Manager, Carlyle Johnson Machine Co., Manchester, Conn.

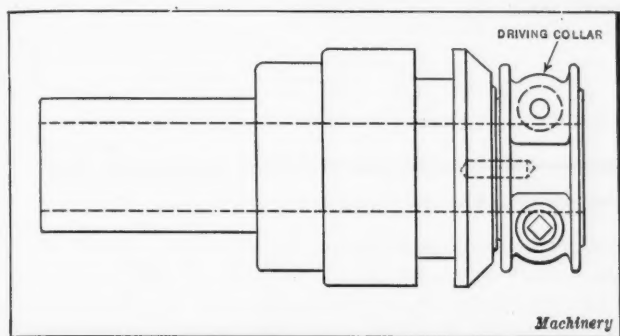


Fig. 1. Clutch for Lineshaft Use provided with a Split Driving Collar

THE application of friction clutches in machine shops, in both lineshafts and countershafts, and as parts of the design of individual machines, is constantly growing. Friction clutches of well-known designs may be used either for power transmission in one direction only, or, when the clutch design is of the double type, for reversing and driving in the opposite direction as well.

For most purposes, the friction clutch is superior in action to a positive clutch, because the engagement is gradual. When unusual conditions are encountered, there is an opportunity for slippage rather than breakage. Furthermore, friction clutches may be designed in an exceedingly simple manner, with very few parts and with adjustable features that make them suitable for a great variety of applications.

As mentioned, friction clutches of well-known designs are made in two types—single or double. The applications of these two types will be briefly reviewed in the following article.

## Applications of Single Type Clutches

There are four specific applications of single friction clutches used for power transmission in one direction only. These are: (1) For overhead lineshafts and countershafts; (2) for the starting and stopping of the main drive of the machine, eliminating tight and loose pulleys; (3) for the

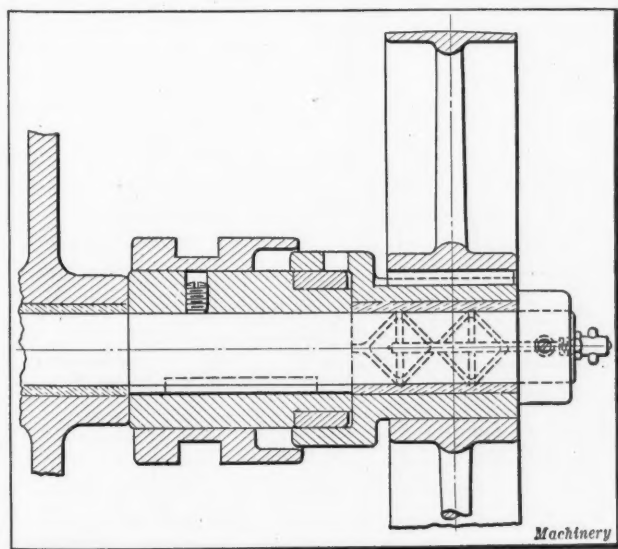


Fig. 2. Friction Clutch arranged for starting and stopping Main Drive of Belt-driven Machine

same purpose as (2), but with the addition of a brake, this type being applied to high-speed machines; and (4) for connecting a motor shaft directly to the driving shaft. There is a fifth application which, however, is not strictly in the same class as the others, because in this case the clutch is used as a coupling rather than as a clutch, and employed for connecting two shafts, much in the same way as a permanent coupling would be used.

## The Use of Clutches in Lineshafts

The use of friction clutches in the overhead lineshaft eliminates the need for countershafts. It permits of a quick, smooth control, as compared with the use of a tight and loose pulley. The pulley on the lineshaft is mounted directly on the loose sleeve of the friction clutch, while the other part of the clutch is keyed or clamped to the shaft; then,

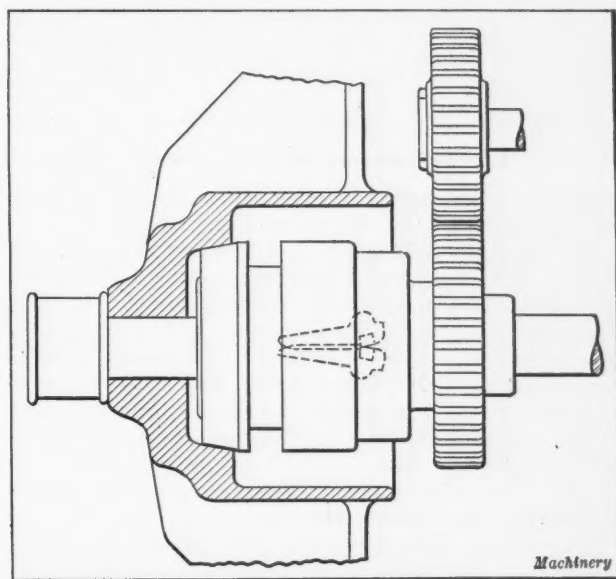


Fig. 3. Friction Clutch applied to a Geared-head Engine Lathe and arranged to act as a Brake when disengaged

by means of the shifting lever, the driving pulley can be instantly released from, or connected with, the lineshaft. The elimination of countershafts saves a considerable amount in power, belting, and pulleys, and makes the entire installation less cumbersome and the shop cleaner and lighter.

For lineshaft use, the single type of clutch can be provided with a split collar, as shown in Fig. 1. This collar is doweled to the clutch body by two driving pins, and clamped to the shaft by means of two square-head collar screws. The bore of the collar is made a little less than the shaft diameter so that it can be clamped tightly to the shaft. In this way, it becomes unnecessary to cut keyways in the lineshaft, and the clutch with its pulley can be moved to any desired position on the shaft very easily.

Friction clutches are sometimes applied to countershafts for the purpose of reversing the drive. In that case a double clutch is used.

## Clutches Used Directly on Machines for Starting and Stopping

Present practice tends largely toward the use of the friction clutch on the main drive of machines for starting and stopping the drive, thus eliminating the need for placing the

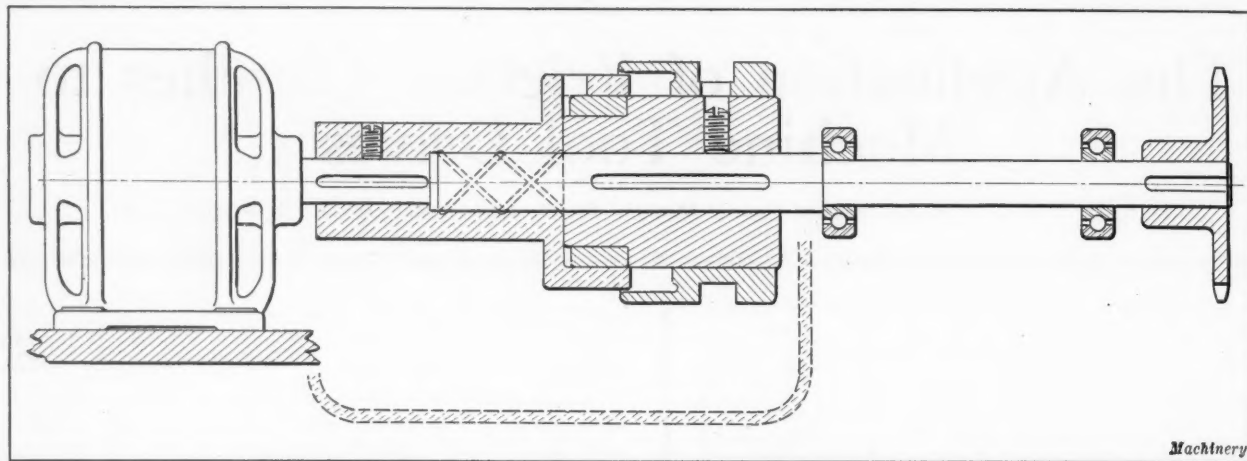


Fig. 4. Friction Clutch employed as a One-way Cut-off Coupling between a Motor and the Machine driven by it

clutches on the lineshaft or in the countershaft. The use of clutches on the main drive of the machine also eliminates the need for tight and loose pulleys. This application of clutches is not limited to belt drives, but may also be applied to spur gear or silent chain drives. The countershaft is eliminated and the entire control of the machine simplified. Fig. 2 shows the arrangement of the Johnson friction clutch in an application of this kind. The member of the clutch that rotates on the shaft is bronze-bushed, it having been found advantageous to mount the clutches in this manner whenever the speeds are high. The same arrangement of mounting would apply if a spur gear or a chain sprocket were substituted for the belt pulley shown in the illustration.

#### Clutches Provided with Brake Feature

Fig. 3 shows an application of a friction clutch to a geared-head engine lathe. In this instance, the sliding sleeve is beveled off at one end to act as a brake so as to stop the rotation of the lathe chuck immediately after the clutch is disengaged. This arrangement, as mentioned, is especially advantageous on high-speed machinery, and provides probably the simplest possible method of combining a disengagement of the drive with a brake. The clutch is geared to the motor pinion or mounted on the driving pulley, and, without any additional parts or attachments, serves as the brake through the engagement of the beveled surface on the end of the shipper sleeve. When the clutch is released the machine stops almost instantly.

This braking arrangement has been found especially desirable in its application to light, high-speed lathes, or for

other machinery that is driven directly from a lineshaft running at high speed, say 500 revolutions per minute or more, as the momentum of the pulley will drive the machine for some time after the clutch is disengaged, unless some means is provided for stopping the driving pulley instantly. A double clutch can be used as a braking arrangement by making the friction cup on one end of the clutch a stationary cup by keying it to the frame of the machine.

#### Clutch Used in Connection with Direct-connected Motors

A friction clutch may be employed as a one-way cut-off coupling in cases where motors are direct-connected with the machines they drive. Fig. 4 shows an example of this arrangement, the motor shaft being permanently keyed to one part of the clutch, while the driving shaft of the machine is keyed to the other, the friction clutch engaging or disengaging the two. This arrangement could also be employed for permanently connecting two shafts, as with a permanent coupling.

#### The Application and Use of Double Clutches

The first use of a double clutch, that is, a clutch able to engage with other members in two directions, was in countershafts for machines that had to be reversed. At the present time, however, the double type clutch is even more frequently used as a part of machines for reversing different motions, as, for example, in tapping attachments and in the feed movements of automatic machinery, as well as for reversing the main spindles in any type of machine tool where such action is required. Fig. 5 shows an arrangement of this kind.

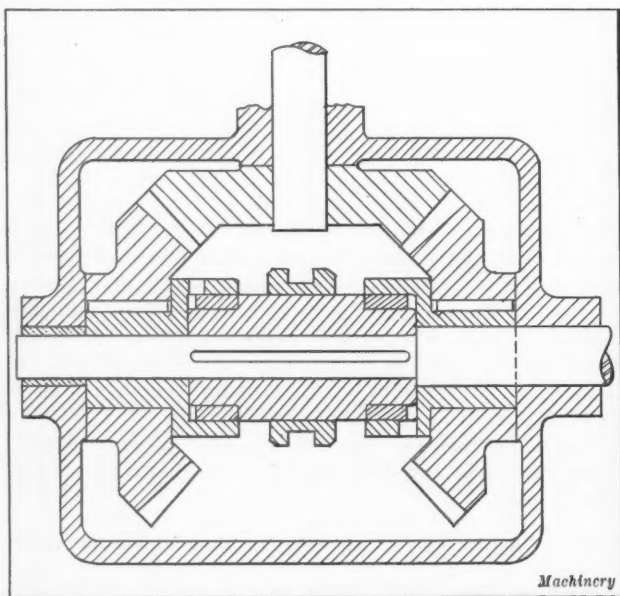


Fig. 5. Double Friction Clutch mounted between Two Bevel Gears for reversing the Drive

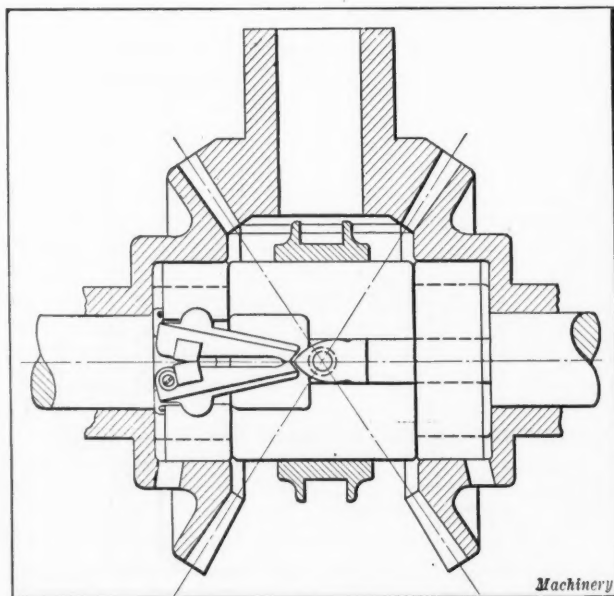


Fig. 6. An Application Similar to that in Fig. 5, but arranged to be mounted in a Very Small Space

Here the double clutch can engage with either of the two bevel gears mounted on the end sleeves of the clutch, and in accordance with which one of the bevel gears is engaged, a reversal of the drive will take place.

Clutches of this type can be designed in an unusually compact manner, as shown in Fig. 6, which illustrates an installation in a tapping attachment for a drilling machine. The clutch is operated by a starting and stopping lever in the front of the machine. When the lever is thrown to the right, the spindle feeds downward; moving the lever to the left reverses the direction of the spindle; while a central position of the lever puts the clutch in a neutral position. By the arrangement shown in Fig. 6 it is possible to mount a double clutch in a very small space and to use it in cases where the other driving members are comparatively small. Applications of this kind are found on numerous machine tools, especially on drilling machines and boring mills.

A similar application of the double clutch is found in horizontal boring, milling and drilling machines, where a double friction clutch is used for obtaining speed changes. Fig. 8 shows an example of this kind. On quantity work it is not practicable to stop the motor every time gears have to be thrown in or out, and the difficulties that are often met with in shifting gears are obviated by having a friction clutch mounted directly in the gear-box, which makes it a simple matter to throw over a lever to stop the machine or change the speed. Designs of this kind may provide for either two forward speeds, one on each end of the clutch, or for one forward and one reverse speed, according to the requirements.

A double clutch can also be used as a cut-off coupling at either end, or as a cut-off coupling at one end and for throwing in and out the feed at the other end. It is not so often used as a cut-off coupling, however, as is the single clutch.

As shown in Fig. 7, a double clutch may be mounted between two belt pulleys for obtaining a forward and reverse drive, one pulley having an open belt and the other a crossed belt. The pulleys may also be made of different sizes, so as to provide for two forward speeds. The example shown is for a tapping machine, a forward and reverse spindle movement being obtained by this arrangement. The examples shown indicate the different applications of single units of clutches. By the use of combination units, (for example, a combination of a single

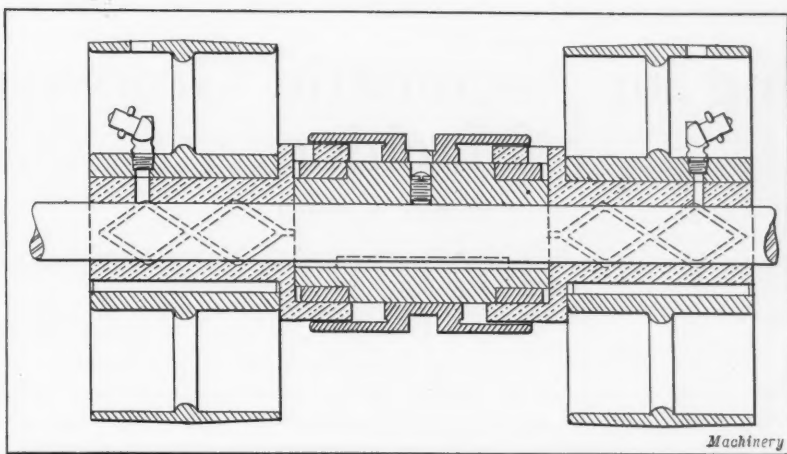


Fig. 7. Double Clutch mounted between Two Belt Pulleys for obtaining a Forward and Reverse Drive

and double clutch) it is possible to obtain control of still more complicated mechanisms. Some machine tools are provided with as many as eight friction clutches for the control of different speeds, feeds, and reversing mechanisms.

The lubrication of friction clutches is an important item that must be specially considered in the case of each application. The speed at which the machine is operated, and the number of times per hour that the clutch is engaged and disengaged affects the method of lubrication, and also the material used in the friction clutch sleeve that runs on the shaft. For some applications, especially at lower speeds, the ordinary high-grade cast-iron sleeves have proved fully satisfactory, but at higher speeds, bronze bushings, as shown in Figs. 2 and 7, have proved more advantageous.

While it is difficult to lay down exact rules, because many other conditions besides speed govern the lubrication, it may be stated that friction clutches of the types shown in the illustrations can be safely operated up to 2000 revolutions per minute. There are a great many clutches in use at the present time in connection with small motors running at 1750 revolutions per minute.

In earlier days, the machine tool builder looked askance upon the friction clutch for many applications, especially at high speeds, but the fact that these clutches are now being applied in an ever-increasing number in different types of machine tools, indicates the possibility of so designing and applying clutches that a reliable operation may be expected.

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Electricity has long been a kind of magic word, it often being implied that better work is done when electric power is used. For example, "Skates ground by electricity" is not an unusual sign to be seen on small machine shops in the winter time. Nevertheless, it must be admitted that there is practically no field at present where electric power or

heat does not play an important part. The latest addition to the list of applications of electricity is the largest bread-baking oven in the world, now in operation in a bakery in Cleveland, where General Electric heating units, with a total rating of 450 kilowatts, are used to heat an oven 80 feet long by 9 feet wide. The heat is automatically controlled through nine circuits in the oven. Costs, it is stated, have been reduced by the use of electrically heated ovens in place of gas-fired ovens.

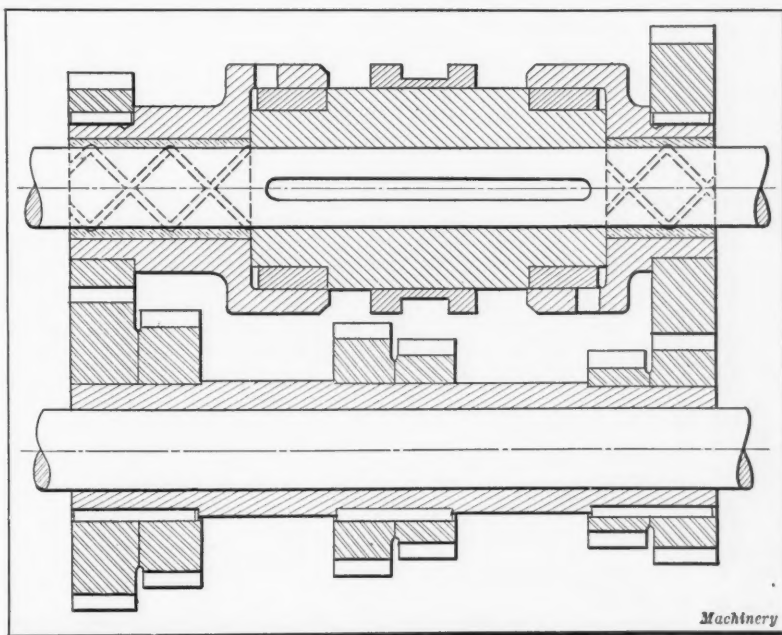


Fig. 8. Double Clutch used for obtaining Speed Changes in a Horizontal Boring, Milling, and Drilling Machine

# Designing an Automatic Groove-milling Machine

By ALBERT A. DOWD

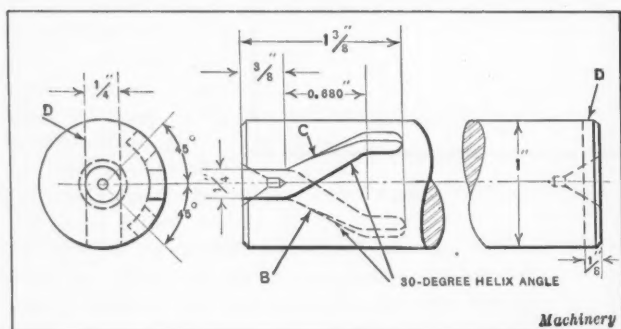


Fig. 1. Work for which Automatic Groove-milling Machine was built

**M**ILLING, turning, boring, drilling, and other operations can often be performed automatically on standard machines by employing special attachments. When this is not feasible or when a suitable automatic machine is not available, it may be necessary to build a complete automatic machine. In Fig. 1 is shown a steel piece that could not be machined automatically in quantities on any standard type of machine. The pieces are made in pairs, one of which has a right-hand spiral groove cut in it, as shown by the dotted lines at B, while the groove in the other is cut left-hand, as at C. There is a straight portion at both ends of the spiral groove as indicated. Previous to cutting the groove, the piece is centered at both ends and a 1/4-inch slot D milled across one end. It is necessary to locate the spiral groove from this slot.

In this case it was desired to make a fully automatic machine with suitable adjustments so that it could be adapted for other work of a similar kind. The machine was required to draw the pieces from a magazine, locate them properly on centers, machine the slot as indicated, and discharge the pieces as fast as they were completed. Fig. 2 shows a side view, and Fig. 3 an end view of the machine that was designed for this purpose. A two-spindle machine was decided upon, because it was desirable to machine a right-hand and a left-hand piece simultaneously. A brief description of the general operation and construction of the machine will be given, the important details being shown by enlarged and sectional views.

Referring to Fig. 2, the pieces A are placed in vertical magazines having tongues at one side that enter the slots D at the end of the work and keep the slots in a vertical position. This is necessary in order to avoid complications in chucking. The pieces feed downward through the magazine by gravity, and are arrested by the reciprocating valve shown at B in Fig. 3. At the proper time, the valve is opened and the pieces drop down on guards, after which the

centers C and E, Fig. 2, are moved forward automatically, and a tongue at F enters the slot as indicated.

In the actual milling operation, the cutter-slides F, Fig. 3, are moved forward to a fixed position with respect to the centers of the work. While held in this position, the entire carriage G, Fig. 2, is traversed at a uniform speed, and at the proper point the driving spindle is revolved by means of a cam-plate H, Fig. 3, through an arc of 45 degrees; at the end of this arc, the path of the cam being straight, the work-holding spindle stops its revolution and travels straight to the end of the cut.

The drive of the machine is through a worm and worm-gear L, Fig. 2, and a camshaft M from which all the mechanical movements are taken. The cutter-spindle has a pulley N, Fig. 3, belted to an overhead drum, which drives the cutter at high speed. The entering and withdrawal movements of the centers are controlled by levers O, Fig. 2, at each end of the machine, which engage cams P on the camshaft. The longitudinal movement of slide G is controlled by another cam at Q, on one side of which is a cam R. The latter cam, through a movement of the roller S, operates lever T, lifting the rod U and opening and closing the valves B, Fig. 3, that release the work from the magazine.

The control of the cutter-slide is through a bellcrank V, Fig. 2, one end of which engages a block W in a cross-slot in block X underneath the dovetail of the cutter-slide. The other end of the bellcrank lies over one of the large cam-drums, and is controlled by a cam Y. With the single exception of cam R, all the cams are of the plate variety, which are bolted to the various cam-drums. When the piece is completed, the cutter-slide withdraws and the centers that hold the work are also pulled out after the slide G has been returned to its original position by the weights Z. When the centers are withdrawn, the piece falls down through an opening and passes out, as indicated by the arrows at A, Fig. 3. The cutter-slide is withdrawn from the work by means of a stiff coil spring shown at B. The two spindles

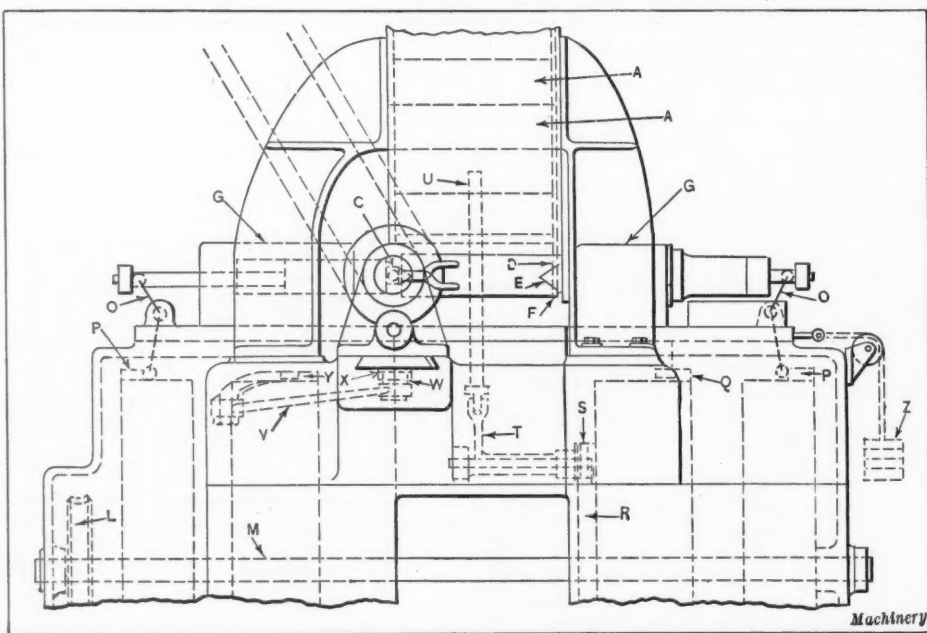


Fig. 2. Side View of Automatic Groove-milling Machine

that carry the work are connected by a cross-bar  $C_1$ . The lever  $O$  bears against the center of this bar.

The cams  $H$  that control the spiral are bolted to the flat surface of the table so that as the slides  $G$ , Fig. 2, move forward, the contact of the ball end  $D_1$ , Fig. 3, with the cam causes the work-holding spindle to move through an arc determined by the shape of the cam and the forward movement of the slide. The return is assured by coil springs attached to the arms at  $E_1$ . The end view, Fig. 3, shows the cam  $R$  in position just before the opening of the valves  $B$  that release the work from the magazine. The roller  $S$ , bearing on the cam, causes lever  $T$  to lift and move the plunger  $F_1$  upward. The upper part of the plunger is connected by links  $G_1$  with the levers that operate the valves, as indicated.

#### Construction of Cutter-slide

Figs. 2 and 3 have been made as simple as possible in order to avoid confusion by a multiplicity of lines, and while these two drawings give a good idea of the machine as a whole and the general method of operation, some details are necessary to give a better idea of the construction. Fig. 4 shows important details of the cutter-slide; the cutter  $B$  is an end-mill having a straight shank  $C$  which is held in a standard form of collet  $D$ . The lubrication of the cutter is through a pipe  $E$  connected to a pump in the base of the machine. The spindle  $F$  has a nose-piece mounted on it at  $G$ , and it has a bearing in the headstock at  $H$  and  $K$ . The pulley  $L$  is mounted between the headstock bearings, and is belted to an overhead drum, as previously mentioned.

The cutter-slide is dovetailed at  $M$ , and provided with a suitable gib for adjustment. The forward movement and the return of the slide are controlled by the block  $N$  which lies in a groove  $O$  on the under side of the slide. The lever  $P$  has a stud in it at  $Q$ , on the upper end of which is a rectangular block  $R$  which is a sliding fit in the cross-slot in block  $N$ . The lever  $P$  is shown at  $V$  in Fig. 2, and is a part of the bellcrank controlled by cam  $Y$ .

It is a comparatively easy matter to set a cutter in the collet to obtain an approximation of the depth of cut required, but as they are likely to be slight variations when clamping the collet, it was considered advisable to provide another means of adjustment for the slide. The block  $N$ , Fig. 4, is a solid piece with a stud  $S$  which enters an elongated slot  $T$  in the cutter-slide, and the block is clamped by the nut and washer at  $U$ . A fine adjustment can be easily obtained by turning the threaded shaft  $V$  through a knob extending beyond the end of the cutter-slide. By this means,

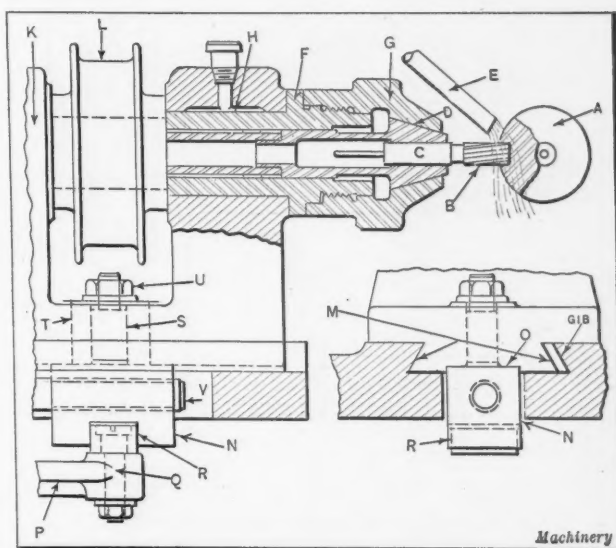


Fig. 4. Cutter-slide of Machine shown in Figs. 2 and 3

the position of the block can be varied with respect to the slide to suit conditions. The collet mechanism is of standard form, and can be tightened from the end of the cutter-spindle.

#### Arrangement of Work-holding Carriage

The arrangement and construction of the work-holding carriage is considerably out of the ordinary. For this reason, a longitudinal section and plan view of the carriage are shown in Fig. 5. The work falls down from the magazine  $A$ , coming to rest on the supports  $B$ , one on each side of the piece. These supports are of semicircular form, and are attached, respectively, to spindles  $C$  and  $D$ , as indicated. The slide  $E$  is very long, and is dovetailed to fit the machine bed for almost its entire length.

#### Headstock and Tailstock Construction

The headstock and tailstock  $F$  and  $G$  are twin castings, located by a tongue in the center of the slide and fastened to the latter by screws from underneath. The center  $H$  is of standard form, and fits the sliding sleeve  $K$ . The latter is keyed at  $L$  to the quill  $M$ , so that it revolves with it, but at the same time is free to move backward and forward in the quill according to requirements. At the forward end of the sleeve  $K$  there are two prongs  $N$  which enter the slot in the end of the work, locating it accurately, and also acting as a driver.

The quill  $M$  has a long bearing in the headstock  $F$ , and is adjusted by means of two threaded collars as shown. A lever of the bellcrank variety is keyed to the end of the quill at  $O$ . One end of this lever is ball-shaped, as shown at  $P$ , and bears against the cam-plate  $Q$ . The latter is so proportioned that the forward movement of the work-carrying-slide causes the spindle to travel through the desired path and thus generate the cut required. The other end of the bellcrank  $R$  is fastened to a stiff tension spring which keeps a continual pull on the ball-point  $P$  so that it is always in contact with the cam. The sliding sleeves  $K$  are connected by a bracket  $S$ , at the center of which is a small hardened plate

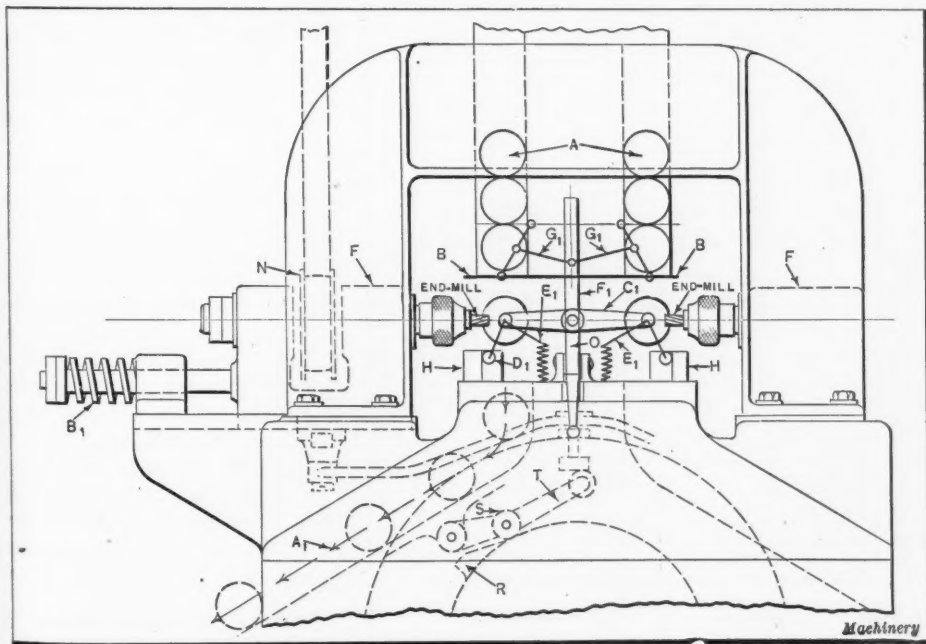


Fig. 3. End View of Machine shown in Fig. 2

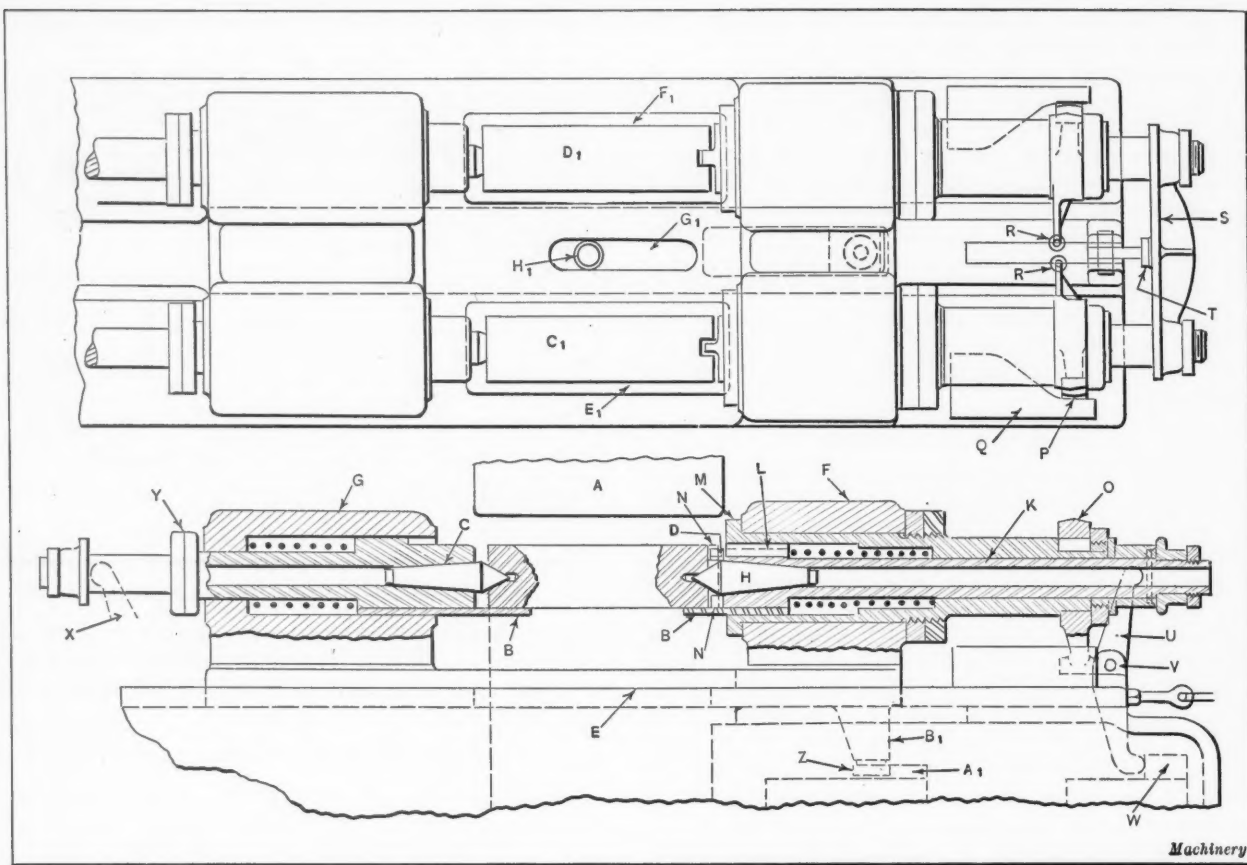


Fig. 5. Work-holding Carriage of Automatic Groove-milling Machine

T. The lever *U* is pivoted in a bracket *V* on the end of the slide, and the lower end of the lever is in contact with the cam *W*. In releasing the centers from the work, lever *U* is pushed backward, thus withdrawing sleeves *K*.

The tailstock spindle *C* is of much simpler construction, but operates in the same manner as the headstock spindle as far as the withdrawal of the sleeve *C* is concerned. The movement is obtained by means of lever *X*, which is the same as lever *U* at the other end of the machine. The collars *Y* are threaded to the sleeve, and can be set to limit its

movement. The entire slide *E* is moved forward or backward by means of roll *Z* which is in contact with cam *A*, as indicated. The roll is supported by a stud in the lug *B*, extending down from the under side of the slide. The machine bed is slotted to allow the lug to pass through. Directly under the work *C*, and *D*, shown in the plan view, there are cored openings *E*, and *F*, into which the work drops when the centers are withdrawn.

Attention is called to the fact that the semicircular pieces *B* that support the work are a trifle in advance of the ends

of the centers. The cam is proportioned so that when withdrawing, the movement is sufficient to allow the piece to drop freely into the openings in the bed of the machine. In moving forward, however, the pieces *B* move up rapidly into a position that allows the work to drop into place without striking the ends of the centers, and immediately after the work has dropped to this point, the centers are released and are driven into position by the springs shown. The pieces *B* are a trifle lower than the normal position of the work so that when the centers enter the piece they pick it up clear of the support. The center of the slide has a cored opening *G*, which permits the rod *H*, to pass up through it. This rod is used to operate the valve mechanism that releases the pieces from the magazine.

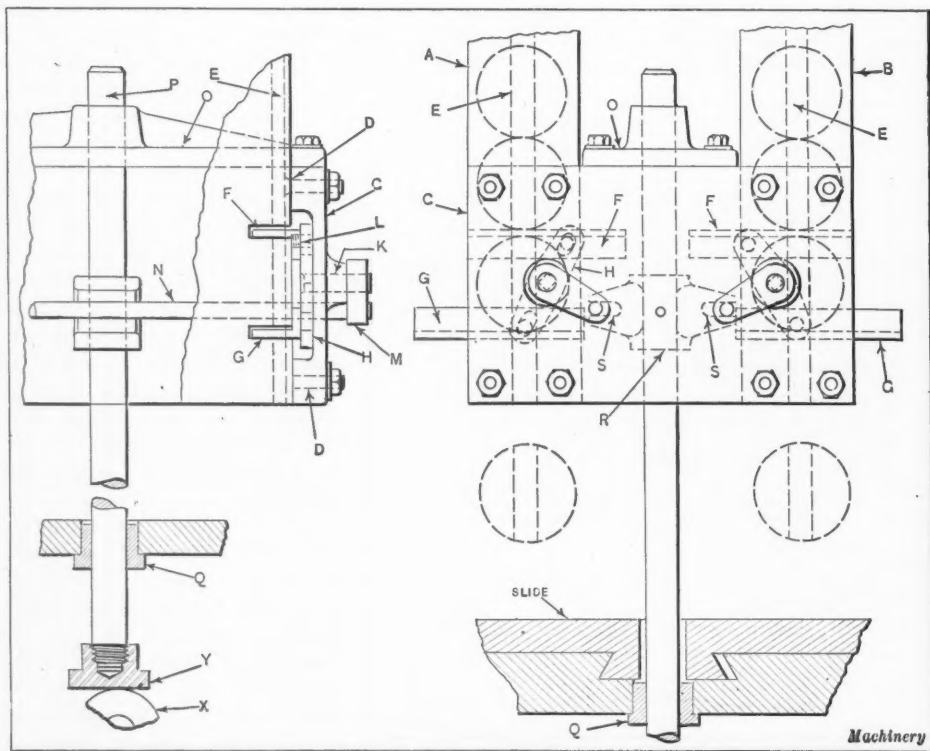


Fig. 6. Magazine and Feeding Valve Mechanism

#### Operation of Magazine Feed

The method of operating the valve mechanism and the details

of its construction are shown in Fig. 6. The twin magazines *A* and *B* are made of heavy sheet metal, and are supported by brackets on the bed of the machine, as clearly shown in Figs. 2 and 3. On each side of the magazine is a bracket *C*, Fig. 6, which extends completely across from one magazine to the other, and is bolted to the magazine by countersunk screws *D*. A steel tongue *E* extends from top to bottom of the magazine on one side only. This tongue enters the slot in the end of the work and keeps it in a vertical position. The valve mechanism consists of upper and lower angular pieces *F* and *G*. These two pieces are connected by a slotted lever *H* which is mounted on a shaft *K* in the bracket mentioned. The pins *L* are screwed into the valves *F* and *G* and enter slotted holes in the lever. At the end of the shaft *K* is a short lever *M* connected with a similar one at the other side of the magazine by means of the rod *N*.

The connecting bracket *O* extends across the magazine between the two sides, and serves as a guide for the operating rod *P*. This rod passes down through the slot in the work-carrying slide, and is guided at its lower end by a bushing *Q* in the machine bed. The bracket *R* is located in the proper position on this vertical rod. At each side of this bracket there is a fork at *S*, and through this the rod *N* passes, connecting the levers at both sides of the magazine.

The lever shown at *T* in Fig. 3, has a roll at one end, as shown at *X* in the detailed view, Fig. 6. This roll bears against a hardened shoe *Y*, which is screwed to the end of the vertical operating shaft. As the roll moves upward it pushes the rod *P* up, and as the bracket *R* is engaged with the cross-rod *N* attached to the valves, the latter are moved outward and inward in unison, according to the vertical movement of the operating rod. This entire mechanism is quite different in its general features of construction from the form often used.

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## LOWERING COSTS WITH A JIG BORING MACHINE

In a Midwestern shop producing tools, jigs, and fixtures on a jobbing basis, constant use is made of a locating and jig boring machine by which parts can not only be bored accurately, but with a great saving in time. Two operations recently performed, which are typical of many done on the machine, are illustrated in Figs. 1 and 2.

The example shown in Fig. 1 illustrates the possibilities of the machine, fifty-one holes having been bored in plate *A* to center distances on which limits of plus and minus 0.0005 inch were specified. The holes range in diameter from 0.281 to 1 1/8 inches. In this operation, after one hole had been laid out and bored, it was an easy matter to locate for boring the other holes, by simply shifting the table of the machine and the boring head the required amounts longitudinally and transversely, respectively.

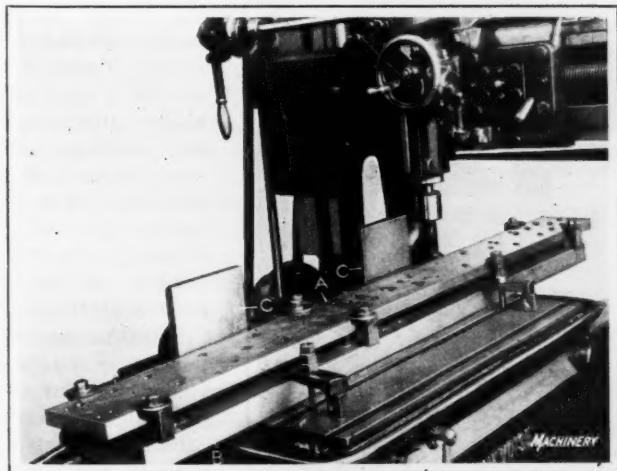


Fig. 1. Boring Fifty-one Holes to Center Distances on which Plus or Minus Limits of 0.0005 Inch are specified

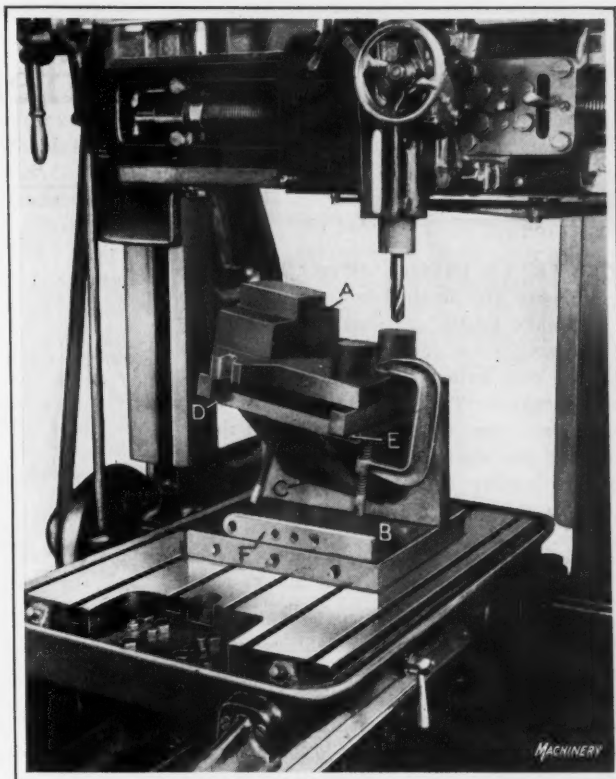


Fig. 2. Boring Two Holes at an Angle by Means of a Special Fixture

The table and head are each fed by revolving separate micrometer screws, equipped with devices that compensate for inaccuracies in the screws. A drum on each screw is graduated to 0.0005 inch and provided with a vernier reading to 0.00005 inch.

This piece of work was longer than the machine table, and so it was necessary to shift the position of the work after about half of the holes had been bored. To facilitate this shifting, the work was clamped on an auxiliary table *B* which, in turn, was clamped to the table of the machine. In starting the operation again after the work had been shifted, a plug was seated in one of the previously machined holes, and a test bar was placed in the spindle; then a gage-block was applied between the plug and the test bar to accurately determine the position of the spindle relative to the holes already machined. Hardened and ground blocks were placed between the work and the auxiliary table, and the latter was located transversely on the table by abutting it against angle-plates *C*.

Fig. 2 illustrates an operation that consisted of boring holes in two bosses on casting *A* at an angle to the finished bottom surface of the casting. For drilling to the required angle, use was made of a special fixture *B*, to the upright of which there is attached a table *C*. The latter can be swiveled around a complete circle on fixture *B* to give any required angular setting of the work. There are two plugs *D* and *E* on the front edge of the table which are used in conjunction with bar *F* to make an angular setting. The hole in one end of the bar is slipped over plug *D*, and then Johansson gage-blocks of proper dimensions are applied between the other end of the bar and the top or bottom of plug *E*, as the case may be, to incline the table the desired amount. An indicator is run along the top surface of bar *F*, and the table swiveled until the bar is shown to be level. The table is then locked for the operation. The two holes were first drilled to 15/16 inch and then bored to 1 inch. The machine is built by a Swiss firm, the Société Genevoise D'Instruments de Physique, Geneva, Switzerland.

\* \* \*

Automotive engineers claim that the mileage of automobiles per gallon of gasoline can be doubled by changes in mechanical design when justified by the price of gasoline.

# Machining Differential Side Gears

By O. S. MARSHALL

**T**WELVE hundred differential side gears are finished per day of nine hours, on the surfaces indicated by the heavy lines in Fig. 1, by the use of two Fay automatic lathes tended by one operator. The essential features of the operations are the method of supporting the work and the arrangement of the tooling equipment. These features will be described in the present article.

## Method of Holding the Gear Blanks

The gear blanks are partly finished when they come to the machines, the hub being faced, the semicircular groove *X* formed, and the hole broached square to 1.067 inches within limits of plus 0.000 inch and minus 0.002 inch. When the gear blanks leave the automatics, they are completely machined, except for cutting the teeth and grinding several surfaces after the heat-treatment. In the operations on the Fay automatic lathes, two gear blanks are mounted on an arbor that is square where the gears are seated, as shown in section *B-B*, Fig. 3. The ends of the arbors are cylindrical, as shown by section *A-A*, and are supported in hardened and ground sleeves contained in the headstock and footstock spindles, instead of being held between centers, as is customary.

On the square part of the arbor at the headstock end, there is seated a drive plate *C*, which is attached to the headstock spindle to furnish a means of transmitting the drive from the spindle to the arbor. The drive plate is allowed to float a sufficient amount to insure equalization of the drive. The footstock spindle is of ball-bearing construction, and revolves with the arbor. Spring-actuated plungers *D* in the headstock and footstock spindles facilitate the removal of the arbor and work from the spindles.

After an arbor has been placed in the machine, the footstock spindle is brought against the right-hand blank on the arbor and clamped in this position so as to hold the left-hand blank against drive plate *C* and thus locate both pieces of work accurately for the operation. Four arbors are provided for the two machines, so that gears may be placed on two idle arbors for immediate substitution in the machines after each operation. The blanks are seated on the square part of the arbors by tapping them lightly with a block.

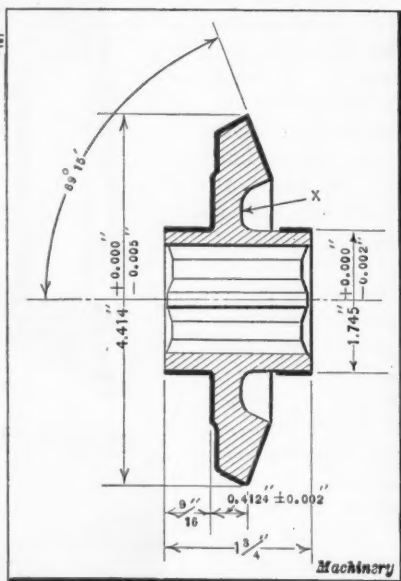


Fig. 1. Automobile Differential Side Gear

## Arrangement of the Tools

The tooling problem was approached from the angle that all surfaces to be finished should be machined simultaneously so as to obtain a minimum amount of idle time. There are eight places on the blank where cutters operate. In Fig. 2, which is a view of the tooling equipment from the rear of the machine, the cutters are shown in position for starting the various cuts, while in the lay-out shown in Fig. 3, the cutters are illustrated in the positions they occupy at the end of the cuts. With the exception of the two-step back face of the blank and the periphery of one hub, only one cut is taken on the different surfaces. Both sets of tools in each machine are identical, and so it will only be necessary to describe the action of one set.

In operation, arm *E* at the back of the machine travels forward in the direction indicated by the arrow, during which movement cutter *G* chamfers the corner of the right-hand hub, cutter *H* profiles the angular tooth face, and cutter *J* roughs the two-step back face and turns the left-hand hub. Simultaneously with these cuts, cutter *K* on the front carriage of the lathe turns the right-hand hub; cutter *L* on a special taper-turning fixture *M*, profiles the outside angular surface of the blank; and cutter *N* mounted on a turning fixture, finish-faces the two-step rear face, finish-turns the periphery of the left-hand hub, and chamfers the corner of the hub.

Cutters *K* and *L* first travel directly toward the work into the cutting position, and then cutter *K* moves toward the left parallel with the center line of the lathe, while cutter *L* moves diagonally, as controlled by former *O*. This former is attached to the footstock by means of a rod and knuckle-joint arrangement which permits different transverse positions of the former, but holds it in a permanent

longitudinal position. Cutter *L* is mounted in a sliding member which is held in contact with the former bar by an internal coil spring. Cutter *K* is held in a stationary holder attached to the carriage, and taper fixture *M* is also attached to the carriage, but cutters *K* and *L* are independent of each other in their action.

It will be observed that cutter *N* is provided with four cutting edges for machining the surfaces already mentioned. The turning fixture on which this cutter

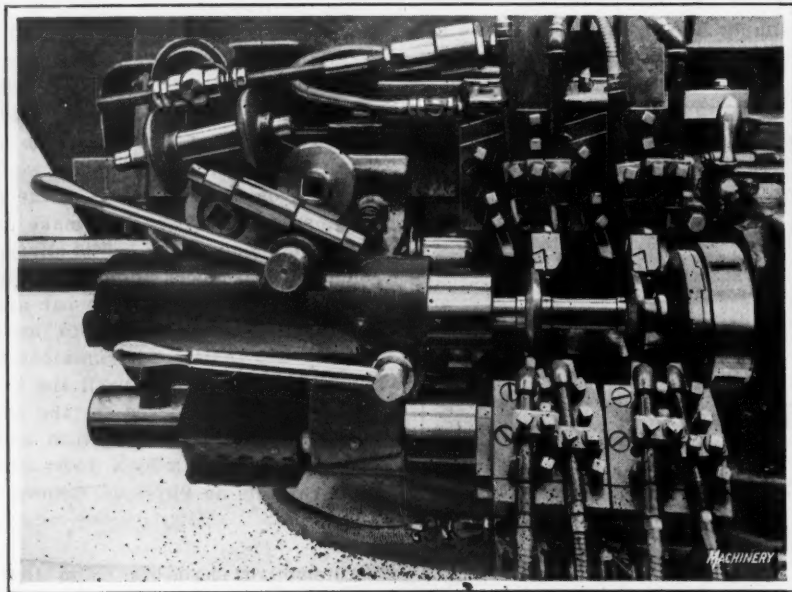


Fig. 2. View of Tooling Equipment from Rear of Machine

is mounted is located directly beneath the work. It is adapted to holding a single cutter or a number of cutters, and these can be positioned either on the front or the rear side of the work. The fixture is mounted on a bar that is supported by the footstock and by a bracket at the headstock end of the lathe. The cutter-holder is movable on a dovetail slide arrangement, actuated by a former, and may be positioned longitudinally relative to the work. The cutting edges of tool N are on the end instead of on the top or edge surface, as in regular practice.

Cutting lubricant is delivered to the various tools in a quantity sufficient to flood away all chips, and the contacts of the drive plate and the footstock spindle against the gear blanks insure cleanliness of the arbor-support sleeves con-

## STANDARDS FOR SHAFTING AND KEYS

Two important dimensional standards dealing with cold-finished shafting, and square and flat shafting keys, recently approved as tentative American standards by the American Engineering Standards Committee, 29 W. 39th St., New York City, have just been published by the American Society of Mechanical Engineers, the sponsor society, and are ready for distribution. The sizes covered are from 1/2- to 6-inch (machinery shafting) and 15/16- to 5 15/16 inch (transmission shafting). The recommended stock lengths for cold-finished shafting are 16, 20, and 24 feet. The keys considered for these sixty standard shaft diameters are either square or flat. The standard widths and heights and the

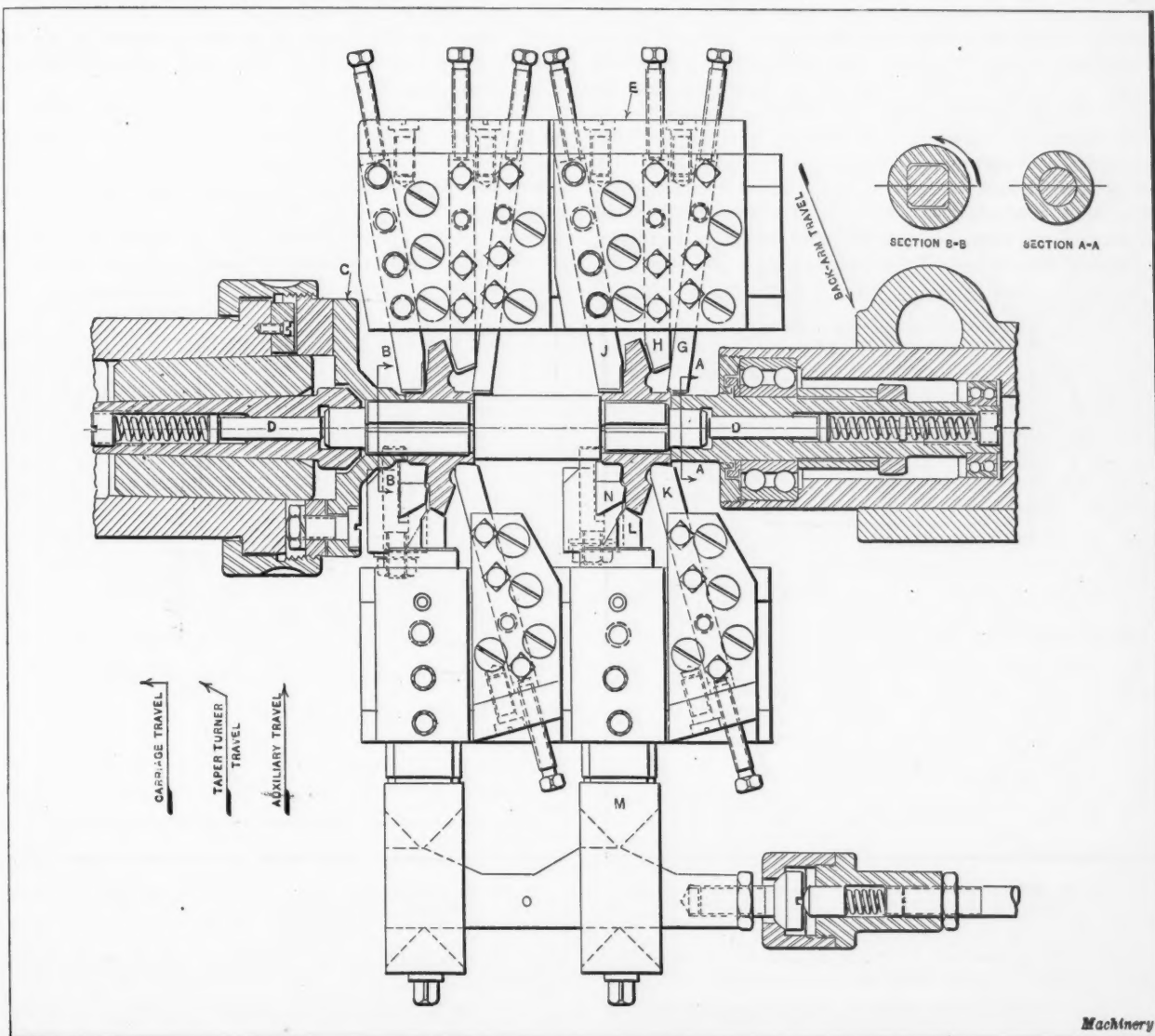


Fig. 3. Tooling Equipment used on Fay Automatic Lathes for machining Bevel Gears

tained in the spindles. One operator, with two machines, four work-supporting arbors, and twenty-four cutters having a total of forty cutting edges, can produce four blanks in 1 minute 32 seconds, which includes 12 seconds for replacing an arbor of finished blanks with one on which rough blanks are mounted, at the end of the operation. On the basis of 85 per cent efficiency, this means a production of approximately 1200 blanks per nine-hour day. The surface speed of the work is 100 feet per minute, and the feed per revolution, about 0.012 inch.

\* \* \*

According to recently published statistics, the automobiles in use in England, exclusive of trucks, number about 800,000. In addition, there are about 250,000 trucks. In Germany the number of automobiles does not exceed 200,000, and the number of trucks is less than 100,000.

corresponding negative tolerances are given. The keys are to be cut from cold-finished stock and are to be used without machining.

In the development of these standards, which was begun in 1918, the whole industry, including not only manufacturers and users, but more than 300 dealers and jobbers, has participated by correspondence, conferences, and representation on the sectional committee in charge. A tentative report published in 1923 was widely distributed. As a result of this, a revised report was again widely circulated for criticism before final revisions were made. The sectional committee is now working on formulas for guidance in the selection of the best sizes for transmission shafting for use under various conditions for loading. The chairman of the committee is Cloyd M. Chapman and the secretary is C. B. LePage.

# Press Work in Agricultural Machinery Plants

Second Article of a Series, Describing Drawing Dies Employed in Producing a Gasoline Tank and a Bowl for a Cream Separator

By C. C. HERMANN

**D**RAWING dies are used in punch presses for producing parts of such depth that wrinkles would result near the top if forming dies were used; dies of the latter type are, of course, entirely satisfactory for shallow parts. In drawing operations, wrinkles are eliminated by exerting pressure on a flange of the work at the same time that the work is being pushed into the die by the punch. Many parts are so deep that they cannot be made in a single drawing operation, but require one or more redrawing operations. This is true of such articles as dishpans and water pails. Drawn sheet-steel parts are used in numerous instances in agricultural machinery and equipment; the dies employed in drawing two sections for a gasoline tank, and one part

other, and then welding the two sections together. In planning the dies for any part, the first thing to determine is the approximate diameter of the blank necessary for the part. This blank size may be found by means of formulas described on page 1126 of the sixth revised edition of *MACHINERY'S HANDBOOK*.

In every case, the drawing die should be made before the blanking die, because it is next to impossible to determine the exact diameter that a blank should be, prior to forming and drawing the actual pieces. In the case of comparatively deep draws, such as these tank sections, the work will always be longer at some points than at others, necessitating a trimming operation before it is completed. Hence, the

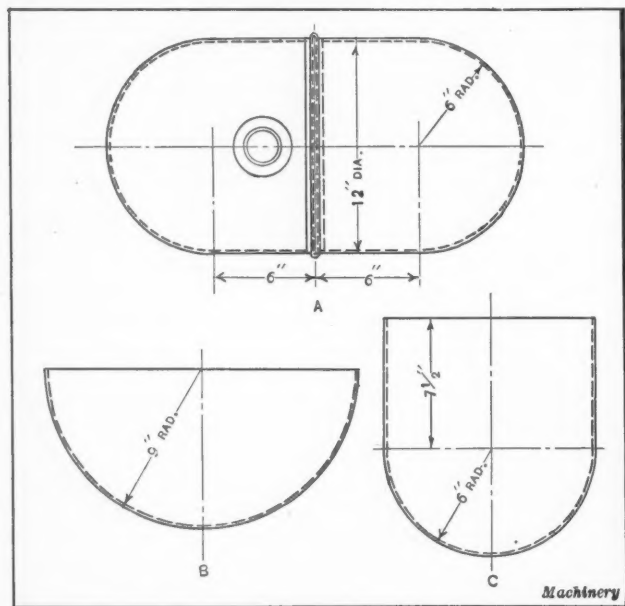


Fig. 1. (A) Gasoline Tank composed of Two Sheet-steel Sections; (B and C) Steps in the Manufacture of the Tank Sections when Single-action Dies are used

that serves as a bowl on a cream separator are described in this article.

In designing dies for a series of drawing operations, the designer is first of all confronted with the problem of determining the reduction that shall be made in the diameter of the work at each draw. The number of operations depends upon the thickness and character of the steel and the design of the dies. It must always be kept in mind that if the reductions are made too great, with a view to finishing the part in a small number of operations, the material will not be uniform in the finished part, and the savings in initial die cost will in most cases be offset by the loss due to parts spoiled in the drawing operations.

## Producing the Sections for the Gasoline Tank

From the view at A in Fig. 1, it will be seen that the sections of the gasoline tank are each 12 inches in diameter and about 13 inches long, the over-all length of the assembled tank being 24 inches. The sections are made from No. 18 gage sheet steel, and each one is provided with a bead near the open end. The two parts are assembled by simply telescoping the bead of one section over the bead of the

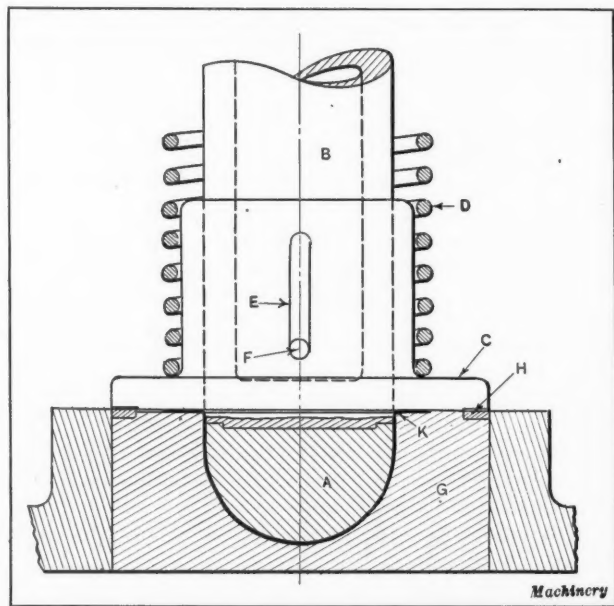


Fig. 2. Die equipped with a Blank-holder, which is used in the First Drawing Operation performed on the Tank Sections illustrated at A in Fig. 1

blank must usually be slightly larger in diameter than is required theoretically.

Each tank section could be completed, with the exception of the beading, in two drawing operations performed in single-action presses. However, the operations would be more in the forming than in the drawing class, and the work would be more or less wrinkled. The first operation would consist of producing the part to the shape illustrated at B, and in the second operation, the part would be produced as shown at C. In redrawing to the shape shown at C, the diameter would be reduced about 6 inches and the length increased at the same time to the desired dimension.

In drawing many parts, the thickness of the metal in the walls is decreased during one operation, but in such cases, the diameter of the part is not changed in subsequent operations. When the thickness is decreased, a die equipped with a blank-holder must be used. A single-action press may be equipped with a spring blank-holder for such an operation, but when a double-action press is used, the blank-holder is actuated by a ram separate from that which moves the punch. Even if the tank sections were produced to the shape illustrated at B in a double-action die, and to the shape

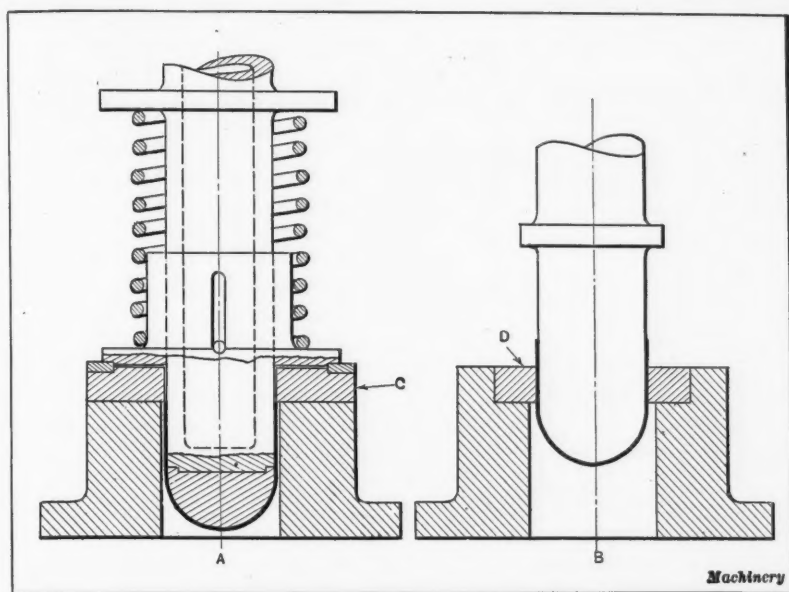


Fig. 3. Dies employed in the Second and Third Operations on Gasoline Tank Sections

illustrated at *C* in a single-action die, there would be wrinkles along the edge of the part that might make it difficult to obtain a tight tank when welding the sections together. Therefore, in planning the dies for producing these sections, it was decided to use two double-action dies and a third single-action die.

The first operation consists of drawing the part to the shape illustrated by the heavy line in Fig. 2, the difference between this shape and that shown at *B*, Fig. 1, being that a flange is left on the part so that it may be gripped by the blank-holder in the second operation. The second operation brings the section to the shape illustrated at *C*, Fig. 1, and almost to the exact size, the third operation being performed simply to size the blank accurately. This method of drawing the piece leaves it smooth, free from wrinkles, and uniform in thickness throughout. The blank-holders of the first two dies grip the stock with a pressure that prevents any tendency of the stock to wrinkle.

As no double-action press was available for making the tank sections, it was necessary to provide a blank-holder on the punch ram for the first two operations. From Fig. 2, it will be seen that the punch of the equipment used in the first operation has a spherical bottom *A*, formed to suit the shape desired in the end of the tank sections. However, the punch is slightly larger in diameter than the finished piece. Piece *A* is attached to a shank *B*, the upper end of which is fastened to the ram of the press. Surrounding the shank is a blank-holder *C*, and between the blank-holder and the upper collar on the punch, there is a heavy coil spring *D*.

When the press ram descends, the blank-holder first comes in contact with the work, and exerts an increasing pressure on it until the punch travels a distance equal to slot *E*, relative to the blank-holder; during this movement the work is drawn to the shape outlined. The travel of the punch relative to the blank-holder is limited by pin *F*, attached to the shank, which slides in slot *E* of the blank-holder. Die *G* is equipped with a ring gage *H*, by means of which the blank is seated properly in the die. Edge *K* is rounded slightly, so that the stock will not

be sheared as it is drawn over this edge. The operation is stopped before the stock is entirely withdrawn from between the blank-holder and the die, in order that a flange may be left that can be gripped by the blank-holder in the second operation.

The die used in the second operation is shown at *A*, Fig. 3. The only difference between this set and that shown in Fig. 2 is in the construction of the die and die-block, the punch parts being the same. In this case, the work is pushed clear through the die, and stripped from the punch by the lower edge of die *C* on the return stroke of the ram.

The third and final operation is performed under the single-action die shown at *B*, which brings the tank sections to size within close limits. However, there is sufficient spring in the metal to expand the part enough after it passes through die *D* so that it will be stripped from the punch by the lower edge of the die upon the return stroke of the press ram. If the tank sections

were produced by single-action dies only, the first operation would be performed by means of equipment similar to that shown in Fig. 2, except that the blank-holder would be eliminated.

#### Dies for a Cream Separator Bowl

A cream separator bowl made from No. 18 gage sheet steel, cut into squares of about 24 inches, is shown in Fig. 4. This part is made to the shape illustrated so as to avoid splashing when pouring milk into it. Especially interesting drawing dies are required to produce this shape. The first and second operations consist of blanking and drawing the work to approximately the required depth with straight sides. Any stresses set up in these operations are neutralized by an annealing process, after which, in the third operation, the bottom is rounded and the part drawn accurately to depth.

The punch and die employed in the third operation are shown at *A* in Fig. 5, from which it will be seen that the equipment is of the double-action type. The punch is equipped with a blank-holder *C*, which grips the blank against die-ring *D* as punch *E* pushes it into the die. This punch is of considerable size, and so in order to reduce the cost of replacements to the minimum, it is provided with

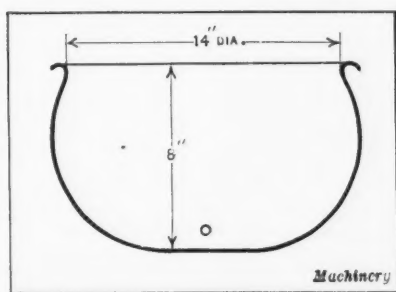


Fig. 4. Outline of Bowl for a Cream Separator

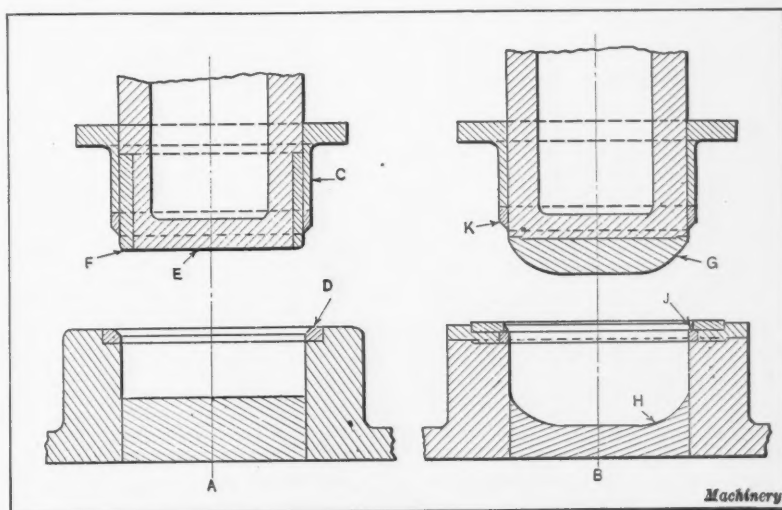


Fig. 5. Construction of the Redrawing Dies used in the Third and Fourth Operations on a Separator Bowl

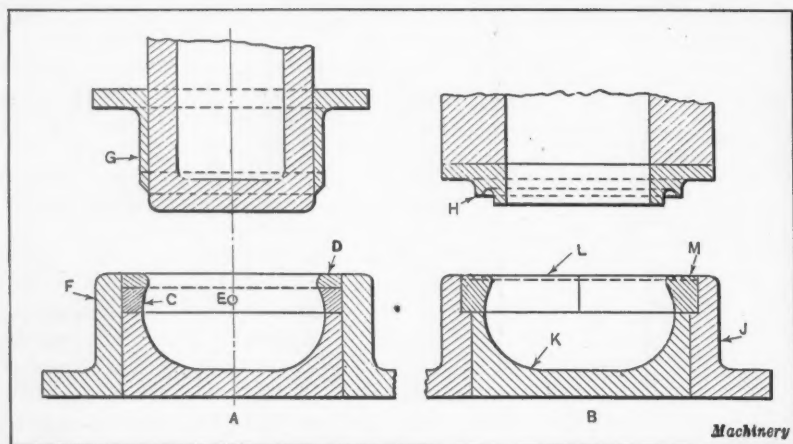


Fig. 6. Bulging, and Curling and Trimming Die Sets used in producing a Separator Bowl

a sleeve *F* that actually does the drawing. Only this sleeve need be replaced when the punch becomes too worn to draw satisfactory work. Sleeve *F* is preferably made of low-carbon tool steel, machined roughly to size, carburized, hardened, and then ground accurately. Ring *D* is simply held in the die-block by machine screws, the lower corners of the ring being rounded off to prevent a shearing action on the work. A knock-out pin is provided in the die-block for lifting the ring, when this is necessary. The die-ring may be made from the same kind of steel as the punch sleeve. When there are no facilities for carburizing, a water-hardening tool steel may be employed in place of the steel mentioned.

In the fourth operation, use is made of the die set shown at *B*. The diameters of the different parts in this set approximate those of the set illustrated at *A*; however, the punch is equipped with a bottom *G* that is rounded to the contour desired in the bottom of the work, and die part *H* is shaped to correspond. The diameter and depth of the work are brought to the finished size within close limits in this redrawing operation. In this case the punch nose is made quickly replaceable, as considerable wear is experienced on this part. A ring *J* is provided on the die-block for trimming the shell, and the punch is equipped with a combination flange-holder and trimmer *K*.

#### Bulging Operation

The next operation, which consists of bulging out the work to the shape shown in Fig. 4, is performed by means of the die set illustrated at *A*, Fig. 6. After the work has been placed in the die, a circular rubber block, which fits fairly close to the straight sides of the work, is laid in it. This block is compressed by the punch when the ram descends, and as it spreads sideways it expands the work to the desired shape. The operation could, of course, be performed hydraulically, but by the method explained, the use of water is entirely dispensed with and the operation has proved altogether satisfactory.

In this punch and die set, the die pieces *C* and *D* are made in two parts so as to permit removal of the work after it has been bulged. The halves of ring *D* are fastened to those of ring *C*, and the two units are matched together by pin *E*, which is inserted through block *F*. A flange-holder *G* is provided on the punch, and the bottom of the punch itself is square, the edges being rounded so as not to cut the rubber. On the return of the ram, the rubber regains its former shape, and can thus be easily removed from the work. Pin *E* is then withdrawn and the work taken out with the upper portions of the die. These die portions are next removed from the work and placed in the die for shaping the next piece.

#### Curling and Trimming the Top Edge

The next operation consists of curling and trimming the top edge of the separator bowl by means of the die shown at *B*. It is possible to perform this operation in a single-action press, since no flange-holder is required. The punch is equipped with a curling ring *H*, on which there is a short extension that reaches into the work and thus controls the inside diameter. The lower half *K* of the die into which the work is seated for the operation is secured in block *J*. The forming ring *L* is made in halves, which are placed around the work under the flange before putting the work in the die. On the descent of the ram, ring *H* engages the flange and curls it as desired. Ring *M* is also made in halves, which are secured to those of ring *L* for trimming the flange

of the work when the edge on the curling ring passes the top of block *J*.

The small hole shown in the bowl in Fig. 4 is provided to receive a faucet. This hole is punched after the curling and trimming operation, and then the bowl is cleaned, tinned, and polished. Some manufacturers make such bowls from aluminum, others from copper, and still others from sheet steel, which is later nickel-plated. The faucet is fastened by soldering. Every bowl is thoroughly inspected after each power press operation, so as to obviate doing any work on spoiled pieces.

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## ALIGNING LARGE CYLINDERS

By WILLIAM S. ROWELL

As the method of aligning cylinders described on page 727 of May MACHINERY does not take into account the sag of the string or wire stretched between the two stands, the inner ends of the cylinders would be slightly lower than the outer ends. This condition is shown somewhat exaggerated in the accompanying diagram. The amount of sag *S* depends, of course, upon the length of the line and the tension upon it. No matter how tight the line or wire is drawn, there will be some sag and if both ends of each cylinder are lined up from the wire, the dimension *A* will be less than *D*, and *B* will be greater than *D*.

If the method of aligning cylinders referred to is used to position the outer ends of the two cylinders, and the inner or adjacent ends are kept parallel by careful gaging, the bores will be accurately aligned, provided the ends or faces have been machined exactly at right angles with the bores. It should be remembered, however, that cylinders bored and faced on horizontal machines are not always faced accurately at an angle of 90 degrees with the bore, and due allowance should be made for such errors. With a well supported piano wire stretched as tight as its tensile strength will permit, very little sag occurs in relatively short runs, but even under ideal conditions there is bound to be a certain amount of sag.

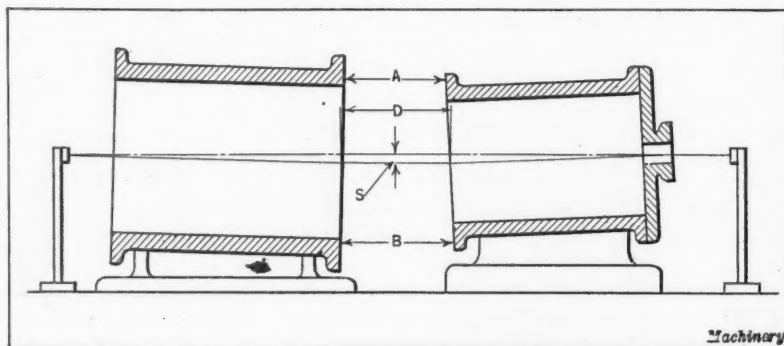


Diagram showing Error in Cylinder Alignment due to Sag of Wire

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## Notes and Comment on Engineering Topics

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The increasing importance of the radio industry is indicated by the increase in foreign shipments in this field. During the first six months of 1925 the value of exports of radio parts and equipment amounted to over \$4,000,000, as compared with \$1,825,000 for the same period in 1924.

A garage for the sole use of buses and trucks will be erected in Boston. This new garage will accommodate 400 buses and trucks, and will also be provided with accommodations for drivers of buses operating between Boston and out of town places, and for drivers of trucks used in long hauls.

After more than a century of continued operation, first using hand power, then water power, and later steam power, the historic Phoenix Iron Co. at Phoenixville, Pa., which played an important part in the World War, the Civil War, and way back in the early days of the Republic, will change its plant to operate entirely on electric power.

In making coils and spirals from small tubing, the Bureau of Standards at Washington has developed a novel method of providing the required internal pressure while bending, by filling the tubes with ice. This material has the advantage of being easily removed after the completion of the bending operation by simply heating the coil. To produce the ice filling, the tube is first filled with water and is then immersed in a mixture of ice and salt to freeze it.

In an address recently made by Alfred Reeves, general manager of the National Automobile Chamber of Commerce, it was mentioned that last year a new automobile was made for every fifty feet of new road constructed. During the past year about 3,600,000 motor vehicles were built, and 35,000 miles of new highway were opened up. The total highway mileage of the country is 2,800,000, of which 470,000 miles are improved roads suitable for automobile traffic.

According to the Department of Commerce, the United States consumes 70 per cent of all the gasoline used in the world. The consumption amounts to 7,780,000,000 gallons. In addition, this country exported 1,220,000,000 gallons last year. Production has increased from approximately 1,500,000,000 gallons in 1914 to 9,000,000,000 gallons in 1924. The per capita annual consumption of gasoline in the United States is 69.3 gallons. The United Kingdom is the next largest consumer, using 11.6 gallons per person.

The discovery of aluminum is generally credited to Wohler in 1827, but a recent article in *Chemie et Industrie* claims that the metal was first prepared by Oersted in 1825. Results of certain experiments that he carried out were published in the early part of 1825, and a specimen of the new metal was presented to the Danish Society of Sciences at that time. In 1826, Oersted published a paper in which he described the properties of the metal that he had obtained, stating that it had a distinct metallic luster.

By an analysis made of the horsepower of automobiles as compared with their weight, it was shown that the less expensive American cars have a power of from 1.3 to 1.5 horsepower per 100 pounds of weight, cars in the medium-priced

class have a power of from 1.7 to 1.9 per 100 pounds of weight, while the highest priced cars have a power of from 2.1 to 2.2 per 100 pounds of weight. Representative English cars have a power of from 1.2 to 1.3, and representative French cars from 1.3 to 1.6 horsepower per 100 pounds of weight.

Underground steam produced by nature, without the intervention of man-made boilers, has been made use of for driving a 35-kilowatt turbo-generator in Sonoma County, northwestern California. The natural steam passes up through 200 feet of 8-inch piping, and according to an accepted theory, emerges from an extensive underground cavern with a layer of spongy rock for a floor, beneath which is a mass of hot lava. Water from surface lakes drips down continuously through numerous passages, circulates through the porous rock, and is transformed by the intense heat into steam which rises into the underground chamber. The steam issues with a steady flow, and has a constant pressure of 60 to 70 pounds per square inch. Considerable difficulty attends the sinking of the shafts for the steam piping. The supply of steam seems to be very large, because a new shaft, drilled within 50 feet of the first one as an outlet for steam, had no effect upon the steam pressure.

It is difficult to realize the extent of the use of grinding in modern industrial pursuits. The making of grinding wheels has become one of the big industries of the country, and the number of grinding wheels produced runs into many millions. One of the large grinding wheel manufacturers states that if the grinding wheels constantly kept in stock were placed side by side in a single row, this row would be twenty miles long. In other words, if the storage racks were laid out end to end in one straight line, they would extend about twenty miles. One million five hundred thousand grinding wheels, comprising from 30,000 to 40,000 different kinds, types, and combinations of wheels, are constantly kept on hand, the floor space devoted to stock storage alone being approximately 52,000 square feet. In this plant approximately 30,000 pounds of bushing lead are used every week. The power required to operate this grinding wheel plant is approximately 3600 horsepower.

Among the important developments in the automobile field are means for cleaning the engine oil as it is being used. "In the past," says Harry L. Horning, president of the Society of Automotive Engineers, "we have been trying to lubricate automobile engines with mud. When oil from the cylinder walls is analyzed it is found to be diluted with products of combustion and partial combustion, metallic matter from the cylinder walls, carbon, and gasoline or kerosene. It is this that is used for lubricating the top piston-ring. It has been found by research that by direct lubrication of the cylinder with clean oil, the pistons can be cooled to such an extent that an engine that knocks badly will cease to knock. With some means of putting clean oil on the bearing surfaces generally, it will not be uncommon for an engine to run from 125,000 to 175,000 miles without having a bearing adjusted. Efficient air cleaners are also of great importance, and will increase the life of an engine greatly. Research on vibration has also shown that very small vibrations can be decidedly disagreeable to the user of a car. It has been shown that a vertical vibration of 0.001 inch and a lateral vibration of 0.002 inch can be very disagreeable if repeated often enough.

# October, 1925 MACHINERY'S SCRAP-BOOK

## SPIRAL AND HELIX

A spiral may be defined mathematically as a curve having a constantly increasing radius of curvature. Spirals are often confused with helices, as for instance, when speaking of "spiral" gears or "spiral-riveted" pipe, which should properly be termed "helical" gears and "helical-riveted" pipe. Both the spiral and the helix are exemplified in spring design, the spiral being represented by a watch spring, while the helix is represented by a coil spring.

## PICKLING CASTINGS

Castings are "pickled" or immersed in an acid bath in order to soften and remove the sand and scale on the surface of the castings, so as to make it easier to machine them and reduce the wear of tools and the time required for their resharpening and resetting. The pickling solutions used for removing scale from castings and forgings preparatory to milling or other machining operations are usually composed either of dilute sulphuric acid, oil of vitriol, or hydrofluoric acid. Iron castings are usually pickled with sulphuric acid. The sulphuric acid pickling solution is generally made up of one part of sulphuric acid to from four to ten parts of water. The sulphuric acid should always be poured into the water while the latter is being stirred. The reason for this is that a chemical reaction takes place which causes the bath to become quite warm, but there is no dangerous ebullition if properly mixed. However, if the water is poured upon the sulphuric acid, the latter, being much heavier than water, remains at the bottom. When an attempt is made to stir the solution, the water enters the acid in small streams, and is instantly raised to the boiling point, generating steam, which may cause an explosion.

## BRASS COLORS

When brass contains 10 per cent of zinc, the mixture has a true bronze color. With 15 per cent of zinc, the brass has a light orange shade. When the amount of zinc reaches 20 per cent, the color of the mixture is greenish-yellow, and is known as "green brass." With 25 per cent of zinc, the color is practically that of the 20 per cent mixture so that this, too, is a "green brass." Brass with 30 per cent of zinc has the true, yellow brass color. The same is found with 35 per cent of zinc, but at about this point the yellow color begins to disappear, for with 40 per cent of zinc, a reddish-yellow color is found. Brass, therefore, that has a reddish-yellow shade will always contain more than 35 per cent of zinc. The "dead line" seems to be about 38 per cent of zinc, for, at this percentage, the transition from the real yellow to the reddish-yellow begins. When the zinc is increased to 45 per cent, the color of the brass is a rich golden shade and may be called "orange." The mixture containing 50 per cent of zinc has also a golden shade, but richer than the 45 per cent zinc alloy. With 55 per cent of zinc, the color resembles that of 14-karat gold. When 60 per cent of zinc is reached, the brass has a yellowish-white shade, and as the quantity increases, the color becomes white, and finally gray.

## PYROMETER PASTE

Salt mixtures made in the form of paste are sometimes used for determining temperatures. Different pastes of various melting points can be placed along a steel bar and inserted in the furnace, retort, flue, or other point where it is required to make a temperature determination, and, by noting which paste melts and which does not, the temperature may be determined.

## PHANTOM PHOTOGRAPHS

An illustration to show clearly some hidden interior part of a machine in relation to and more distinctly than other parts is usually obtained by first making a wash drawing from which a halftone is produced. This method is expensive, and the results are often unsatisfactory. The desired result may often be obtained by photography. Assume, for example, that in a power-driven machine, the power is transmitted through worm-gearing and a positive clutch, enclosed in an oil-tight case. An illustration showing the worm and worm-wheel in mesh is desired. The case and its contents are removed from the machine and mounted on a box. The upper part of the case is taken off, leaving the worm-wheel and the clutch collar exposed to view. The worm and shaft are removed from the upper part of the case and placed in their proper position in relation to the worm-wheel. A dark background is placed in the rear and an exposure is made. After the exposure, the cap is put on the lens, the worm and shaft taken away, and the upper part of the case put in position. A light background is substituted for the dark one, and another exposure is made on the same plate.

## OXYGEN

Oxygen is one of the chief constituents of the atmosphere, in which it is present to the extent of 21 per cent by volume or 23 per cent by weight. The atomic weight of oxygen, which is taken as 16, is used as a standard by which the atomic weights of other elements are compared and determined. The specific gravity of oxygen (air = 1) is 1.106. Its specific heat at 32 degrees F. is 0.217. It becomes liquefied at a temperature of  $-183$  degrees C. ( $-297$  degrees F.), and solidifies at a temperature of  $-235$  degrees C. ( $-391$  degrees F.). Oxygen does not itself burn, but it is the greatest supporter of combustion known, and nearly all other chemical elements combine with it under evolution of heat. Oxygen is used in many industries; in the machine industries, it is used in large quantities for oxy-acetylene and oxy-hydrogen welding of metals and cutting of iron and steel.

## FRICTION LOSSES IN ENGINES

The principal losses in steam engines are due to friction, cylinder condensation, leakage, incomplete steam expansion, "wire drawing," and excessive clearance volume. The friction losses in the best types amount to only about 5 per cent of the total power produced, the percentage of frictional loss decreasing as the horsepower output increases.

## STRUCTURAL ALLOY STEELS

When plain carbon steels are used for construction purposes, chemical analysis and tensile tests prove, in general, a fairly satisfactory indication of suitability, especially when the question of weight of construction is not of particular importance. However, the advent of high-powered machinery, and especially of automobiles and airplanes, has resulted in a demand for material that will withstand exceptionally high stresses, and the question of lightness is of prime importance. These demands have created a wide market for alloy steels which, incidentally, are used nearly always in the heat-treated condition. The study of alloy steels, and the specific influence of the metals entering into them involves, in addition to chemical and tensile tests, microscopic methods of examination, impact tests, vibratory tests, and various other tests, the object in each case being to reveal some new information that will assist the engineer in designing for maximum efficiency and light weight.

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# MACHINERY'S SCRAP-BOOK *October 1925*

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## INDUCTION MOTORS

Electric motors for use on alternating-current circuits may be divided into three groups—induction, synchronous, and commutator. The induction motor is much more extensively used than the others. Commercial induction motors have a stationary element called the "stator," and a rotating element called the "rotor." The induction motor derives its name from the fact that the secondary member or rotor receives its electrical energy from the primary member or stator by magnetic induction, there being no electrical connection between the stator and rotor windings. The transformer is the most commonly known piece of electrical apparatus, in which one winding receives its electrical energy from a second and independent winding by magnetic induction; hence, it is common practice to consider an induction motor as a transformer with a stationary primary and a revolving secondary. Thus, the stator is often called the "primary," and the rotor, the "secondary." The windings are so placed in the stator slots as to cause a rotating magnetic field to be produced when alternating current is supplied. The rotor of an electric induction motor must revolve at a speed somewhat lower than synchronous, in order that a secondary current and a torque shall be created. The actual speed of an induction motor is, therefore, less than the synchronous speed by a few per cent, called the "per cent slip." The slip increases with the load, thus increasing, by the cutting of lines of force, the current in both secondary and primary windings, and the torque.

## SKELP PLATES

The plates used in the manufacture of tubes and pipes are known as "skelp plates." These plates are rolled to such a width and thickness as will produce the desired diameter and strength of tubing. The edges are generally sheared for large sizes of pipe. Grooved skelp plates are rolled in mills having grooves cut into the rolls equal to the width of the plates.

## ANEMOMETER

The anemometer is an instrument for measuring the velocity or pressure of the wind, and may also be used for measuring the velocity of air in pipes of large diameter. Experiments have shown, however, that anemometers are not reliable for the measurement of velocities of air in pipes, especially when the diameters do not exceed 24 inches, the instrument generally giving too low results when used in this manner. It has also been found that the percentage of error is not constant, but varies considerably with the diameter of the pipe and the speed of the air. Anemometers are divided into two main classes, those that measure the velocity and those that measure the pressure of the air or wind. There is, however, a close relationship between the pressure and the velocity, so that an instrument of either class can easily be made to give direct readings for both of these quantities.

## BRAKES FOR BENDING SHEET METALS

A bending brake is a form of press used in sheet-metal work for forming strips and plates. Brakes are made in both hand-operated and power-operated types. As compared with other presses for forming sheet metals, brakes are wide between the housings and are designed for holding long, narrow forming edges or dies for giving the flat stock whatever shape is required. Brakes are used extensively in the manufacture of various kinds of metal furniture, and for miscellaneous sheet metal bending and forming operations.

## LIGNITE OR BROWN COAL

Lignite, also known as "brown coal," contains less than 50 per cent of carbon and over 50 per cent of volatile matter, and has a heating power per pound of combustible of from 11,000 to 13,500 B.T.U. Lignite may be divided into two classes: (1) Sub-bituminous coal, also known as lignite, black lignite, brown coal, lignitic coal, etc.; this kind resembles bituminous coal, is black and shiny, but disintegrates more rapidly when exposed to the air, and its heating value is not as high as that of bituminous coal; (2) lignite, also known as brown lignite or brown coal, is distinctly brown in color and has a woody structure. It contains from 30 to 40 per cent of moisture, and has a lower heating value than any of the other coals. It is, in fact, intermediate between coal and peat, and is fragile, splitting into small pieces when exposed to the air.

## MOISTURE IN COMPRESSED AIR

The atmosphere contains a certain amount of moisture or water vapor, and its capacity for moisture increases with the temperature. When compressed, this water vapor is carried with the air through the pipes to places where the air is to be used, and, as the air is often cooled considerably during its passage through long pipe lines, the water vapor has a tendency to condense. This water due to condensation frequently causes trouble. Moisture or water cannot be entirely eliminated from service lines, but much of it may be deposited by proper cooling devices. Moisture enters the compressor in the free air and passes into the intercooler, where some of it is deposited by the sudden temperature drop there. In some machines, this deposited water is drained off, but, in others, it passes with the air into the high-pressure cylinder, and the heat of compression readily absorbs it again, passing it directly to the reservoirs. If an aftercooler (this is a nest of cold tubes of a construction exactly similar to that of the intercooler) is placed between the discharge pipe of the high-pressure cylinder and the reservoir or service lines, the temperature of the air will be suddenly reduced to normal, and most of the water will be deposited where it can be drained off easily. The idea is to insure the reduction of the temperature of the discharged air to normal before it enters the service pipes. Another way is to connect at least three reservoirs in series so that the air has to pass through all of them before entering the lines. This will collect the water very well, but it is necessary to drain the reservoirs frequently.

## STRIPPER PLATES OF CAM-OPERATED TYPE

Owing to the tendency that stationary stripper plates attached to dies have to distort pierced sheets, etc., some presses are equipped with cam-actuated stripper plates. The stripper plate is attached to vertical rods which extend up above the press slide. When the press is in operation, the stripper, which is actuated by cams on the press shaft, descends first and clamps the stock before the punches enter the work. As the stripper plate is suspended above the die, a clear space is left between the punch and die, so that the operator has an unobstructed view. The stripper plate moves up and down with the punches, so that the latter can be made shorter than would be possible with a stationary stripper, thus increasing their rigidity and durability. This method of stripping the stock is particularly adapted for gang punching and perforating operations, especially when the punches are small in proportion to the thickness of the stock and when it is essential to guide them close to the surface of the work.

# What MACHINERY'S Readers Think

on Subjects of General Interest in the Mechanical Field

## SPHERICAL TURNING ATTACHMENT

The engine lathe of today is something on the order of what the real estate agent would describe as "all improvements in and paid for." It has practically all the features and can be provided with all the attachments that can make an engine lathe more useful. However, it seems that there is one attachment not generally available that might prove very useful. This is an attachment or arrangement for machining spherical surfaces. Such an attachment could be easily designed by arranging for a worm-gear drive at the compound-rest swivel. The other features, such as the location of stops, feed indicators, etc., are matters of design and could be taken care of without great difficulty.

EDWARD HELLER

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## TECHNICAL WRITING

In almost every branch of the field covered by MACHINERY, there are men who have specialized knowledge of equipment and methods that has never found its way into print. Probably much useful information of this kind is lost, because many skilled workmen have so little confidence in their ability to write articles for publication. To these men, the writer would like to offer a few suggestions that have helped him in the preparation of technical articles.

First, it is necessary to have a clear idea of the thing to be described. Next, write down the description or information on paper. Never mind how poorly your sentences are formed at first; just write out the facts so that the description, from beginning to end, will be down on paper. Then let the work rest for a day or two, and when the mind is fresh, return to the subject and read what has been written. You can then see many places where improvements can be made. Even when good grammar, correct punctuation, pleasing composition, and correct spelling are absent, but where the subject is a good one and the description complete, the editor will have the article rewritten in a satisfactory manner.

It is a waste of time to submit an article that deals with a well-known subject in the ordinary manner. No editor, for instance, will publish and pay for an article dealing with the calculation of the horsepower of steam engines that is worked out in the manner commonly employed. A good idea poorly expressed is far more welcome than a perfect description of some generally known method or mechanism. It is well to remember that methods and devices that make for economy or increased efficiency may be familiar to the writer but unknown to a great many others in the industry. By making the useful knowledge gained through practical experience available to others through articles published in technical journals, the writer is helping in the development of the industry and training himself to think in an orderly manner.

A. EYLES

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## MAKING THE SAME MISTAKE TWICE

Too often we encounter engineers whose actual engineering work is of a character that does not greatly differentiate it from that of the practical foreman. It is not expected of the average engineer, particularly of the young technical graduate, that he should have the manual skill or practical knowledge of a skilled mechanic. The technical schools do not pretend to make mechanical experts of the men they train; but they do aim to instill in their minds a few fundamental principles underlying all engineering,

among which is the finding of the cause of an encountered difficulty. The cause having been found, it is expected of the engineer that he will not fall into the same error again. The mechanic may be excused for making the same mistake twice, or even oftener, particularly if he has encountered the difficulty from a different angle each time. He is not expected to anticipate his errors, nor is he in a position to take the necessary steps to prevent a repetition of them, except as his experience and common sense may teach him.

With the engineer it is a different matter. Once a mistake has been made, it should be his duty to investigate *why*, to trace each contributing factor to its source, to take the necessary steps in safeguarding against any repetition of the error, and to make a permanent record of the circumstances. Unless these things are done, he has not fulfilled the functions that are expected of an engineer.

A. M. MORRIS

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## THE SHOP LIBRARY

How many shops recognize the value of maintaining a good up-to-date reference library? In every shop and factory there are men who have a desire to acquire technical knowledge. These men can usually be observed during noon hours in the shop reading technical journals. They are generally subscribers to a journal devoted to their particular work, and many of them have a fair-sized library of technical books at home.

Nevertheless, it is of considerable value in every plant to have within the shop a fairly complete collection of books on such mechanical subjects as pertain to the work done in the shop. There should be a reading room in connection with this library. It need not be elaborate; some corner of the shop could be partitioned off for this purpose, and a clerk could be put in charge of it during the noon hour, so that the shop men could have access to the reading room at that time. This room should contain the leading technical journals in the field, and in addition to books on specialized machine shop subjects and technical literature pertaining to the line of manufacture within the plant, there should be a good mechanical encyclopedic work for ready reference. Many employers would be surprised to find how many men would spend their noon hour in a reading room of this kind.

Reference to technical journals prompts the writer to mention that it is not only the editorial pages, but also the advertising pages that contain much interesting and valuable information for the men in the shop, as well as for the machine designer and the executive. A progressive mechanical man, whatever position he occupies in the plant, must keep in touch with the latest developments in the design and operation of machine tools, and for this information he can depend on the advertising pages of the journal, together with the articles that describe the new machinery and tools brought out from time to time.

To the manufacturer of machines, the advertising pages are an advance salesman who presents the facts to an audience much greater than the individual salesman can reach. Many a sale has been made fully as much by convincing a shop man through the advertising pages as by persuading the purchasing agent by direct contact with a salesman.

E. A.

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Of the automobiles in use in Great Britain, 65 per cent cost less than \$1000, 20 per cent between \$1000 and \$2000, and 15 per cent over \$2000.

# Using Automobile Parts in Machine Construction

By DONALD A. HAMPSON

IT is not generally realized that the rapid advancement of the machine trades in recent years has been due more to the automobile business than any other single factor. For instance, the unusual stresses to which the steels used in automotive transportation equipment are subjected, and the unprecedented quantities of steel required made a vast amount of research necessary, with the result that there are available today, grades of steel peculiarly adapted to almost every conceivable purpose, and at a price that is ridiculously low in view of the large sums spent in research and in revolutionizing the steel-making processes.

Equally marked improvements have been made in ball and roller bearings, bearing materials, foundry processes, finishes, and finishing methods. Machine shop practice has changed and advanced by leaps and bounds, due largely to the improved cutting tools developed in response to the demands for higher production in the automobile factories. The development of the single-purpose machine tool, though not exclusively automotive, has been fostered by the needs of this industry. Forgings and metal stampings are now available for general purposes, and they are supplanting castings in many cases, as they have the advantages of lower cost and increased strength for the same weight.

As a result of the growth of the automobile business, the designer of today has at his disposal a wealth of products that may be worked into special machinery, fixtures, and equipment. Bearings, gears, forgings and stampings, steels and alloys, lubricating devices—these are but a few of the things that once had to be specially made at excessive costs, and that sometimes proved to be of poor quality. Now these things are kept in stock, as motor car parts or otherwise, and a design may be laid out that incorporates them.



DONALD A. HAMPSON was born in Middletown, N. Y., and obtained his technical education through correspondence school courses and other means of home study. He entered the machine shop field in 1901 as an apprentice, and has since worked as a machinist, draftsman, designer, and mechanical engineer, mainly with Morgans & Wilcox Mfg. Co., Middletown, N. Y., manufacturer of printing plant equipment. He has designed special machinery for numerous lines of manufacture, and tools and fixtures for small interchangeable manufacturing, including small arms, automobile accessories, and hardware specialties. Some of the inventions he has patented are being successfully manufactured at the present time.

Some examples of the use of automotive parts are given here. They cover a range wide enough to suggest a multitude of other applications. The mechanism or machine in which these parts are used will be better and cheaper because of the high standards of quality demanded by the automobile manufacturer and the manufacturing methods employed. Some of the examples given include the use of new parts, while some portray the use of second-hand material, unfit for further automotive use but perfectly satisfactory for general machine shop purposes, where the factors of safety and wear need not be so high.

In Fig. 1 is shown an automobile worm drive applied to a motor-driven planer, replacing a spur gear drive that was unsatisfactory principally because of its noisy operation. In this case, a worm-driven axle from a motor truck was secured from an automobile wrecker for practically nothing. New gears of a 4:7 ratio were secured at a price but little higher than that of the set of spur gears they replaced. The worm-gear housing was cut off at each side and capped. The shaft end was left projecting so that it could be connected to the planer countershaft.

The gear-case A was inverted and mounted on brackets B, as shown in the front elevation. It will be noted that the motor was turned at right angles to the conventional position, and that low raising blocks C were placed under it. Thermoid flexible couplings D were used to join the shafts of the reduction unit with the motor and countershaft. The torque of the drive is taken by the brackets under the gear-case and all thrusts are provided for within the unit itself.

Transmitting but 10 to 15 horsepower, this drive is good for many years service, and is quiet and satisfactory. An interesting point in connection with this application—one that throws a side light on shop practice as well—is that,

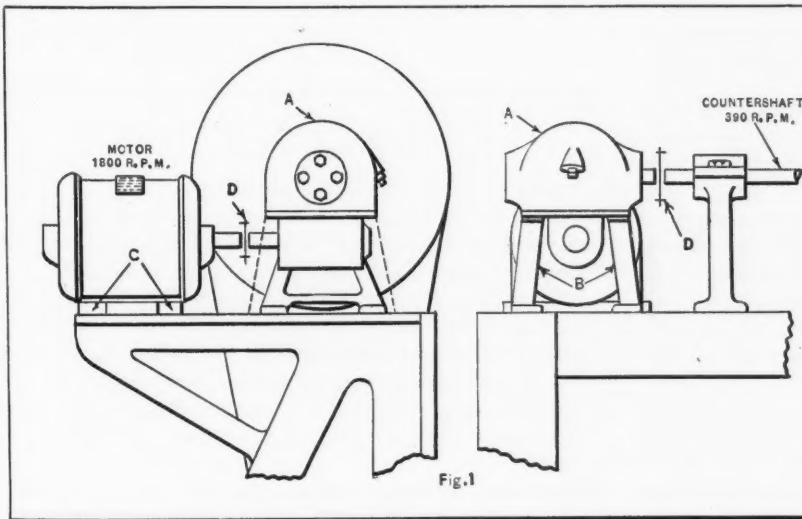


Fig. 1. Automobile Worm Drive applied to Planer

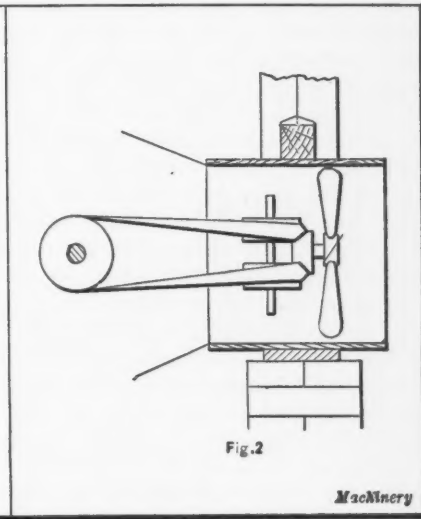


Fig. 2. Radiator Fan used for Exhaust Blower

while the countershaft speed was reduced 80 revolutions per minute, the output of the machine was not lessened. When the worm drive was applied, new gears of the lowest available (numerical) ratio were secured, but these did not bring the shaft up to its former speed. However, the greater adhesion of the belts at the slightly reduced speed, the better control of the table, and the quicker reverse obtained as a result of the decreased momentum of revolving and reciprocating parts made up for the decreased table speeds.

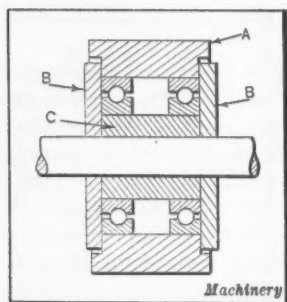


Fig. 3. Ball-bearing Loose Pulley

A battery of two-spindle milling machines was modernized for single belt drive, and the speeds increased at the same time, by placing a drive shaft at the back of the machines and using silent chain drives to connect the driving shaft with the spindles. The 1 3/8-inch drive shafts were mounted in plain bearings, but trouble developed as a result of the high speed, intermittent lubrication, and dust. This trouble was eliminated by putting Timken roller bearings in the new brackets. The roller bearings were obtained from a nearby automobile service station which had discarded them because the cups had been injured slightly, but not enough to spoil them for use on the brackets. The installation was made with the bearings set with their cones opposed, so that the thrust was balanced. Collars were used to retain the inner race. After the roller bearings had been installed, no further trouble was experienced.

#### Exhaust Blower made from Radiator Fan

Three exhaust blowers for polishing machines in a country plant were made up as shown in Fig. 2 from radiator fan units. The polishing machines were shifted slightly, so that each was in front of a window, and three Ford radiator fan units were bought at a garage and installed in wood tunnels made to fit the window frames under the raised lower sash. The fans exhausted the injurious abrasive dust directly out of doors, which was not objectionable at that point. The fan was driven by a belt from a pulley on the machine. Very little power was required to drive the fan, which was in operation only when the machine was in use.

#### Brake for Stopping Lineshaft

Two hundred feet of shaft running in ball bearings and carrying nearly a hundred pulleys, many of them of large diameter, continued to rotate for over half a minute after the power was cut off. A minor accident led to the installation of a brake that could be applied to stop the shaft more quickly on cutting off the power. Since the installation of the brake, its value in quickly stopping the shaft when a belt breaks, for instance, has been demonstrated so that it is now considered to be as necessary a part of the equipment as the controlling switch of the motor. The possibilities as a safety measure, should an accident occur, are also fully realized. It is not assuming too much, perhaps, to predict that shaft brakes will become a regular feature of safety insurance requirements.

This particular brake was made entirely from automobile parts, except for the attachments. The supporting brackets and the pull-rod below were made of rods and bars. The brake handle was located overhead out of the way, but within reach, and in such a position that the full weight of the body is available for breaking purposes. With this brake, a man of slight build can stop the shaft in eight seconds.

The brake has for its drum, the smooth surface of a coupling. A slight bending of the automobile break band made it fit the smaller circle. The usual lining was applied with copper rivets. The toggles were standard automobile parts, direct from the stock bins. A pull-rod was used in

preference to a chain, the chain being more likely to cause accidents in case it should swing into the moving machinery. Near the brake is an alarm bell and the motor starter. This gives a centralized control and a safety installation.

#### Ball-bearing Loose Pulley

Loose pulleys have always been a source of annoyance, especially in industrial plants where high shaft speeds are used. The higher speeds and heavier drives now used in machine shops have made them a greater source of trouble than when slower speeds were employed. Anti-friction bearings have proved very effective in eliminating this trouble. In Fig. 3 is shown a ball-bearing loose pulley that one plant has found inexpensive and satisfactory. This plant has many loose pulleys about 5 and 6 inches in diameter, and as these run faster than the larger pulleys, they give more trouble. The plan adopted was to standardize ball-bearing pulleys of these diameters and have spare pulleys always on hand.

As will be noted, the pulley itself is merely a ring A machined concentrically all over. Two end plates B, an iron bushing C to fit the particular shaft size, and a pipe spacer constitute the various parts. All the work on these pulleys is straight turning and facing. The ball bearings were available in quantities, and were bought for a quarter apiece. They had been taken from their original bearings because of play between the members—a play that was wholly unimportant in their new application. The sizes lent themselves admirably to the work in hand, and their availability at so low a cost made possible a pulley that would otherwise have been too expensive to be considered.

#### Tapping Machine made from Automobile Parts

In Fig. 4 is shown diagrammatically an interesting application of bevel gears taken from the rear axle or differential of an automobile. These gears, shown at A, B, and C, are used to drive the spindle of a single-purpose tapping machine

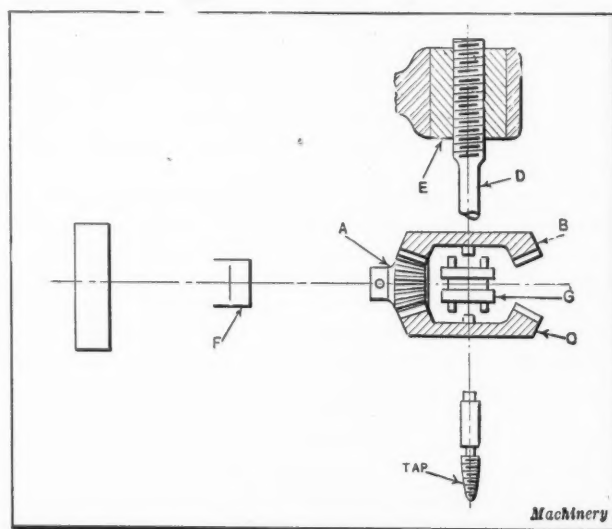


Fig. 4. Diagram showing Automobile Parts arranged to form a Tapping Machine

built for use in a manufacturing shop. It was desired to have the reversing gears in compact form, but it was a foregone conclusion that the use of stock gears for this relatively heavy work would necessitate frequent renewals.

As threads of only one pitch were to be tapped, the spindle D was made threaded at its upper end where it travels in a bronze nut E, which serves also as the spindle bearing, the lead of the thread, of course, matching that of the tap. The horizontal pulley shaft has a friction clutch at F, which is set so that it will slip if undue stresses are imposed on the tap.

The sliding member G between the two gears, and the fork that controls it, are also stock automobile parts. The sliding

member was annealed before being machined to form a part of the pin clutch. The vertical movement and the direction of rotation of the spindle are controlled by a hand-lever. The bevel gears have already undergone considerable hard usage without any sign of wear.

#### Metal Drum-shaped Flasks

A small foundry had two sizes of wheels and gear blanks that were run off at every heat. Square wooden flasks were used, but the extra labor involved and deterioration made a change to round flasks desirable. Wishing to obtain these flasks without going to the expense of making ring patterns, a number of steel rims from truck tires were secured from a junk man. These were light and strong, and the two sizes picked up left about 2 inches of sand around the respective patterns. Simple patterns were made for the trunnions and bars of the cope. A few simple drilling and tapping operations produced a set of flasks from the old truck tires that has proved ideal for this job.

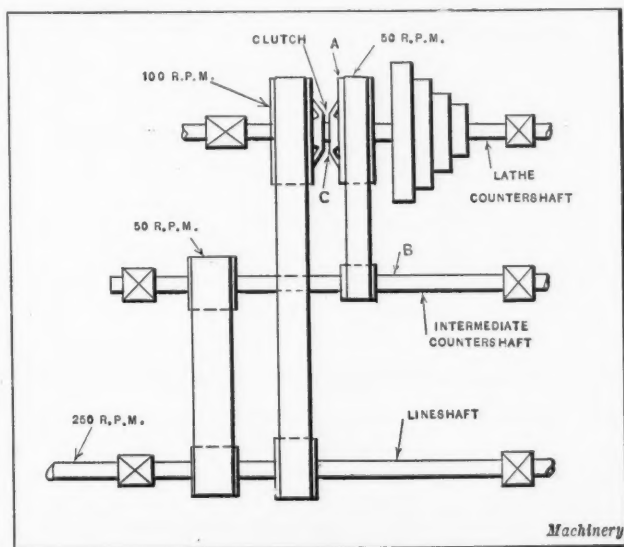
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### PROVIDING ADDITIONAL SPEEDS FOR LATHES

By H. L. WHEELER

The accompanying illustration shows how an intermediate countershaft was added to a lathe drive to provide additional spindle speeds. As the lathe with which the intermediate countershaft was used did not require a crossed belt for threading, the second pulley *A* on the countershaft was employed to give additional speeds. With this arrangement, the necessity for using back-gears to obtain low speeds is practically eliminated, and in fact, the back-gears are not needed except when unusual power is required for taking very heavy cuts.

The intermediate shaft *B* is simply a short piece of shafting, set up about half way between the lineshaft and the lathe countershaft. It can, of course, be used to obtain



Arrangement for providing Additional Speeds for a Lathe

either an increase or a decrease in the spindle speeds, as desired, by the installation of pulleys of suitable sizes. The additional speeds obtained by this arrangement are especially useful when employing relieving attachments for backing off taps, cutters, and similar work. One of the advantages is that the spindle speeds can be changed from high to low by simply shifting the clutch *C*.

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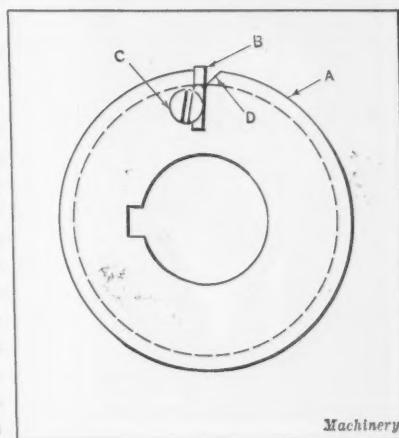
As a result of Switzerland's water power development program a total of approximately 2,000,000 horsepower of hydro-electric energy was developed up to the end of 1924. Additional power stations now under construction are expected to furnish 295,000 horsepower.

### INSERTED-TOOTH WORM-WHEEL HOB

By S. W. BROWN

A worm-wheel hob suitable for an experimental or emergency job is shown diagrammatically in the accompanying illustration. It consists of the hob body *A*, made of cast iron or machine steel, the toothed strip *B* which fits into the slot in body *A*, and two screws that hold the inserted blade in place. The screws, one of which is shown at *C*, are located at each end of the body in such a position that the under side of their heads is in contact with the counterbored ends of the inserted strip.

The first step in making the hob is to turn the body *A* to the same dimensions as a standard hob blank, and then saw a slot in the blank to receive the toothed strip. The slot must be so positioned that the cutting edge of the teeth in the inserted strip will be on a radial line or a plane passing through the center of the hob body. The toothed strip is preferably made from a high-grade tool steel that will change its form very little in hardening.



Inserted-tooth Worm-wheel Hob

The strip is next fitted snugly into the slot, and the holes for screws *C* are drilled, tapped, and counterbored. With the strip thus assembled, the thread is cut in the hob, the same as when making a solid hob from tool steel. After the threading operation, the strip is removed and the diameter of the body *A* reduced about 0.010 inch. The thread is also cut deeper so that the inserted blade will project at least 0.005 inch above the bottom of the thread in the body.

Chip clearance is provided by chamfering the ends of the thread at *D* near the cutting edge of the inserted blade. The teeth of the inserted blade are backed off by filing, after which the blade is hardened, tempered, and assembled in the body, thus completing the hob ready for use. The worm-wheel is gashed and set up in a milling machine in the usual manner, and the operation of hobbing is the same as with a standard hob, except that a slower feed is used, as the cutting is all done with one row of teeth.

\* \* \*

Most machine tool builders are continually experimenting and doing a certain amount of research work on their own initiative and responsibility. There has been little exchange of the results obtained from such research work. A vast amount of this research work is of a general nature that can be done better and cheaper by cooperative effort under the direction of an organization like the National Machine Tool Builders' Association, in cooperation with other associations, societies, and schools seeking like information. It is the hope of the National Machine Tool Builders' Association that in the near future this association will be able to cooperate in research with such laboratories, and that the information thus obtained will enable us to hold our reputation as designers and builders of the best machine tools. We need research that will lead to a higher refinement and larger productive efficiency of all machine tools; but this requires cooperative effort. In cooperative research, any industry learns that it pays, not only to contribute financially, but to contribute time and effort toward raising the standard of mechanical efficiency of its product, and to raise the standard of morals in the industry's business dealings. —O. B. Iles in a paper read before the A. S. M. E. at New Haven, Conn., September 9.

# Machining Differential Housings

By I. F. YEOMAN



I. F. Yeoman\*

SIX and one-half minutes is the average floor-to-floor time consumed in machining the enclosed type of differential housing shown in Fig. 2, on the surfaces indicated by the heavy lines. The operation is performed in a Foster universal turret lathe equipped with the tooling illustrated in Figs. 3 and 4. The housing is a malleable-iron casting with a flange about 9 inches in diameter. Roughing and finishing cuts are taken on each of the surfaces indicated, none of

which is ground subsequent to the turret lathe operation. There is a total of six machining steps in the operation.

The sequence of the steps is as follows: (1) Rough-face the flange surface *A*, Fig. 2, turn surface *B* to receive the ring gear, rough-bore holes *C* and *D*, rough-turn surface *E* of the outer hub, and face end *F* of the same hub; (2) finish-bore holes *C* and *D*, finish-turn surface *E*, and finish-face end *F*; (3) rough-face the inside surfaces *G* and *H* of the hubs; (4) finish-face surfaces *G* and *H*; (5) round the corners of holes *C* and *D* where they meet surfaces *G* and *H*; and (6) ream holes *C* and *D*.

Surface *A* of the flange and the ring-gear seat *B* are rough- and finish-faced and rough- and finish-turned, respectively, by forged cutters held in the square turret mounted on the cross-slide. In each case, the depth of the cuts is accurately governed by means of indexing stop-screws located on the carriage. The cuts are taken simultaneously with the boring of holes *C* and *D*, and the turning and facing of the outer hub. The roughing cuts on the holes are taken by tools in a boring-bar held in the slide on Side 1 of the hexagon turret, as illustrated in Fig. 3, while the roughing cuts on sur-

faces *E* and *F* (Fig. 2), are taken by tools mounted in the same slide. The tools used in the second step are mounted in the slide attached to Side 2 of the hexagon turret, and are similar to those mounted in the holder on Side 1, as the finishing cuts are a duplication of the roughing cuts.

The boring-bars used in these two steps extend for piloting purposes into a bushing pressed into the chuck. It is necessary to mount the boring-bars in slides so that the center of the bars may be shifted relative to the center of the work, to permit passing the first cutter on the bars through the hole in the outer hub prior to taking the cuts. After passing either bar through this hole, it is raised until central, in order to locate the tool for taking the cut, a positive stop on the slide locating the bar accurately in both the central and offset positions.

The third and fourth steps of rough- and finish-facing the inner ends *G* and *H* of the hubs, requires the insertion of a facing cutter in the bar after it has been passed through the first hole. These steps are taken by identical tools in bars held in Sides 3 and 4 of the hexagon turret. The depth of the cut in these steps is controlled by stops provided for

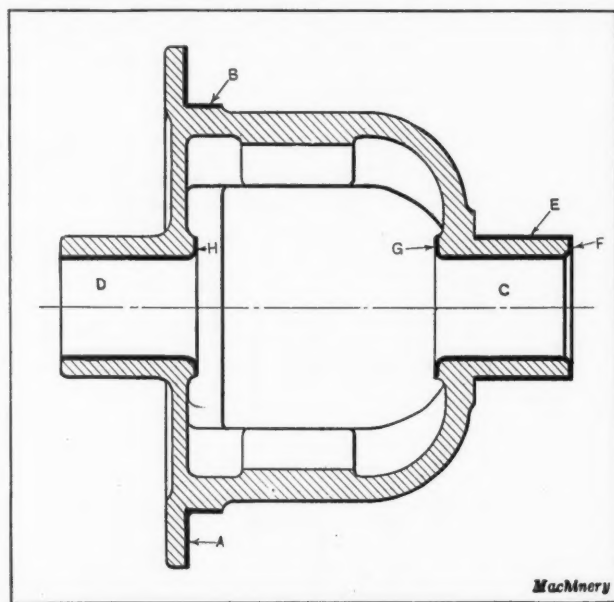


Fig. 2. Differential Housing finished in the Turret Lathe as indicated by the Heavy Lines

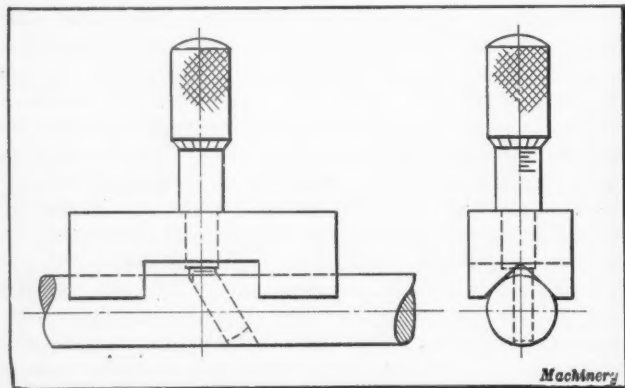


Fig. 1. Gage used in setting the Cutters of the Boring-bars radially, for boring Differential Housing shown in Fig. 2

limiting the forward and return movements of the hexagon turret. At the end of the steps, the cutter must be removed from the bar before the latter can be backed out.

To round the corner of the holes at the inner end of the hubs, use is made of tools held in a bar in the slide tool attached to Side 5 of the hexagon turret. The cutters of this bar must also be shifted relative to the center of the work, in order to enter the cutters through hole *C*. Accuracy of this movement is again obtained by means of stops on the slide. The sixth step, which consists of reaming the holes by means of the reamer mounted in Side 6 of the hexagon turret, completes the operation.

All boring-bars, etc., are provided with shoulders that seat against finished faces of the tool-holders, and duplicate bars are kept in the tool department, with the cutters ground and correctly set as regards diameter. These features are time-savers, because all that is necessary to replace worn cutters is to remove the bar and cutters in the machine and insert another bar with the cutters ground and set correctly. If

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only the cutters were replaced, the cut-and-try method of setting them in the bar would have to be employed. This would cause a delay that would curtail production considerably. The method explained will be found profitable in any similar operation where the production warrants making bars in duplicate sets.

Fig. 1 shows the gage used in setting the cutters in the boring-bars. The cutters are usually ground and backed off while in place in the bar, and with the bar supported on centers.

\* \* \*

### CREDITS ON FOREIGN SALES

In discussing the selling of machinery on credit abroad, W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, states that a careful study of the present situation shows that there is very little demand that machinery for export be sold on credit—and this applies to British and continental manufacturers as well as those of the United States. There is almost no occasion to sell machinery on credit in any European country, with the exception of Poland and Spain, although there have been times when requests of this character have come from Germany, Austria, and Czecho-Slovakia. Most machinery sold in Asia is sold for prompt payment. In South America, there is some request for credit, but quite commonly the business can be done on conservative lines. For example, in most of these countries it will be found that the machinery dealer sells to his customer on some such basis as one-third with order, one-third on delivery, and one-third after test. Such terms enable the dealer to operate with almost no capital. For after making delivery, he has outstanding only one-third of the contract price minus his own profit, while during the early months of the period involved he has had the use of his customers' money to the extent of one-third of the contract price. It is felt that such terms are entirely businesslike and protect the interests of both buyer and seller.

During the war, as a military measure, allied interests arranged for the liquidation of certain German firms engaged in business in Hongkong and Singapore, and those in charge of these liquidations have reported that they found many of these German companies in a most unsatisfactory position. Credits had been extended unwisely, and companies that had seemed to be prosperous were in reality found to be almost worthless. Time and again foreign markets have been demoralized by the too liberal extension of credit. Not long ago a firm in Spain was liquidated, involving a number of American manufacturers in serious losses.

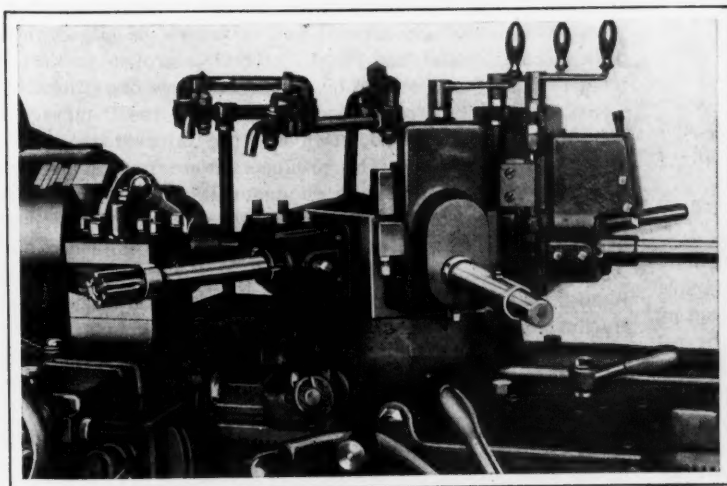


Fig. 4. Tooling Equipment used in machining Differential Housings

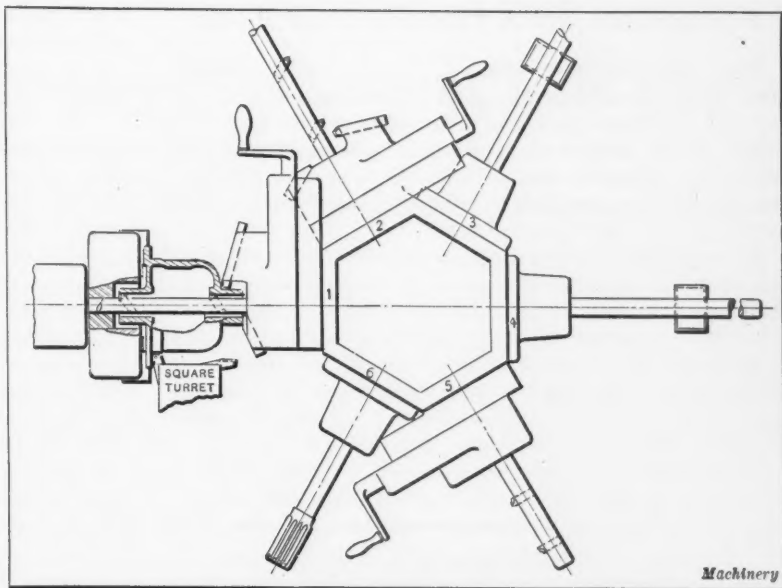


Fig. 3. Lay-out of Tooling Equipment for machining Differential Housings

Large companies and small companies, British and German, as well as American, have suffered serious losses through the too liberal extension of credit in connection with export business. The export manager will find it much more difficult to secure satisfactory credit information than his associates handling domestic business, and in general it is felt that great caution should be exercised in following recommendations to be liberal with credit.

\* \* \*

### MOUNTING GRINDING WHEELS PROPERLY

In an article in the *Pacific Factory*, D. A. Bary calls attention to a recent accident in San Francisco which illustrates the danger of mounting grinding wheels improperly. In this particular instance, most of the grinding was done on the side of the wheel. The guard with which the machine had been equipped was wider than the wheels that the company wished to use, and therefore interfered with the work. Instead of cutting off a portion of this guard, it was removed entirely. This was the first unsafe move.

Next, it was found that the six-inch flange, which was standard equipment, did not leave enough surface for grinding, so it was removed, and a three-inch flange substituted on the outside, leaving the six-inch flange on the inside. This was the second mistake.

Naturally, side face grinding tended to wear a bevel surface on the wheel, and when this became so pronounced as to give difficulty in grinding, the wheel was reversed. This created another hazard, as the large flange did not grip at its edge, but at some point nearer the center. When the wheel was placed in position and the nut tightened, the wheel was cracked, and almost immediately after the spindle was started, the wheel flew into fragments. One of these struck the operator in the forehead, but as the wheel had not attained its regular speed, the injury was slight.

The danger in using flanges of different sizes on the opposite sides of a grinding wheel lies in the fact that the flanges are relieved in the center. When the nut is tightened, there is a tendency to punch the center out of the wheel. When the worn wheel is reversed, the large flange has no solid grip on the wheel, and there is unequal pressure on the two sides of the wheel.

\* \* \*

In considering whether a given business practice is contrary to accepted ethical principles, one need only ask, "Would I object to my competitor doing this in competition with me?"

## POLISHING ON A PRODUCTION BASIS

While there has been a great deal written about automatic and semi-automatic machine tools for turning, milling, drilling and grinding, there has been comparatively little published on the subject of polishing by means of automatic equipment. However, special machines have been developed for this purpose, making it possible to perform polishing operations at a high rate of speed.

The accompanying illustration shows about one-half of the full length of an automatic polishing machine built by the Robinson Automatic Machine Co., Detroit, Mich., for polishing cast-iron and brass hot-air registers. This machine is in operation at the plant of the International Heater Co., Utica, N. Y. It finishes the rough register castings complete without any preliminary or subsequent operations, except, of course, the copper-plating and buffing for final finish.

Briefly described, this machine, which is automatic in its movements, carries twelve belt-driven polishing wheel-heads, each moved back and forth as required, so that they pass over the entire surface of the registers while the latter are being fed lengthwise along the machine under the wheels. The over-arms from which these wheel-heads are suspended are counterbalanced at the rear of the machine so that the wheels cannot gouge the work. Each register passes under all twelve wheels successively.

It is evident that if the wheel-heads were swung back and forth from their overhead support without any compensating arrangement, the wheels would travel along a circular arc, and hence could not be used for polishing the flat registers, which require that the wheels move over them in a horizontal plane. This is taken care of by providing arc-shaped tracks, as shown at A in the illustration, over which a trolley wheel travels, attached to the pendulum support of the wheel carriage. At the ends of this curved track there are blocks that abruptly stop the trolley wheel at each end of the stroke and prevent it from digging into the work during the time that it dwells, before starting on the return stroke. If some of the polishing wheels are not in use, they may be raised from the surface and supported in the raised position by holding the trolley wheel on a hinged member which can be swung over the curved track for that purpose. The machine may be so adjusted that certain wheels will be in an advanced position while others are receding. This arrangement compensates for the vibration of the machine, and enables work of a better quality and a uniform standard to be produced.

The table or conveyor on which the work is carried is chain-driven, and has frames or pockets in which the registers are placed. The latter are held in position by their own weight. Registers 24 by 27 inches up to 40 by 40 inches are regularly handled on this machine. The rate of feed of the carriage is about 8 inches per minute, and hence it requires about 3 minutes for the wheel to cover the entire surface of a small sized register, and about 5 minutes for the larger sizes. Usually, the production rate is about 120 small registers daily. The machine is provided with a blower system, including an exhaust pipe back of each wheel unit, so that all dust is removed. This blower system is driven by

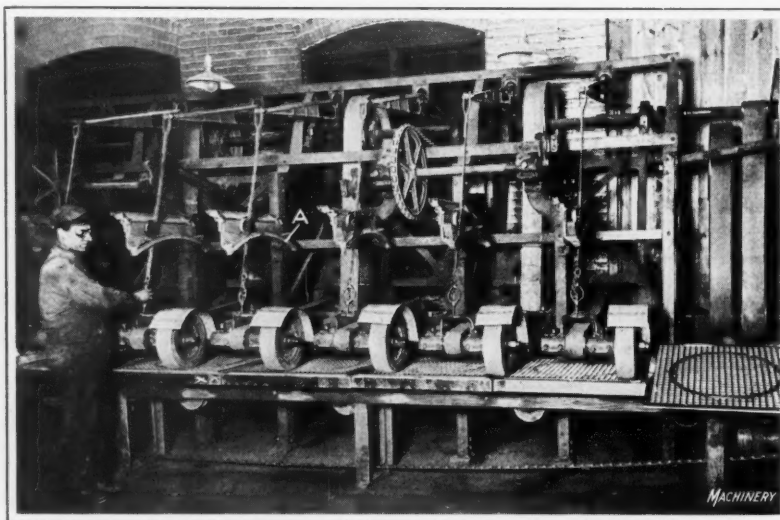
a 10-horsepower motor, the machine itself being driven by a 30-horsepower motor.

As mentioned, there are twelve wheel-heads on the machine. The first two wheels are solid grinding wheels, made from No. 60 carborundum. The registers are first surfaced by these two solid wheels, the conveyor gradually advancing them to the next four wheels, which are compress canvas wheels of medium density, with 2-inch cushions. The face width of these wheels is 4 inches, and they are set up with No. 60 alundum. The registers are then advanced to the next three wheels, which are of the same size and construction as the preceding ones, except that they are set up with No. 90 alundum. The two following wheels are also compress canvas wheels of medium density, set up with No. 120 alundum, while the final polishing wheel is set up with No. 150 alundum. Polishing wheels that have been properly set up for this work can be used for about one day without redressing.

The method of setting up the wheels for this machine has been carefully worked out. The International Heater Co. has installed a gluing room where the wheels are redressed and prepared for use, and carefully worked out directions

are followed in this process. The wheels are dressed off with a carborundum stick while they are mounted in a special machine, after which they are given a coat of thin glue, rolled in emery, and allowed to dry one hour at a temperature of about 70 degrees F. A second and third coating of glue are then applied, of a slightly thicker consistency than the first. All of these coats are applied with a brush. After the second and third coating, the wheels are allowed to

dry thoroughly for forty-eight hours before being used.



Polishing Hot-air Registers automatically on a Twelve-head Machine

## COLORS FOR COMPRESSED GAS CYLINDERS

The Industrial Accident Commission of the state of California recently requested the American Engineering Standards Committee to undertake the standardization of color markings for the identification of compressed gas cylinders. It has been proposed that this suggestion, together with the proposal of the War Department for the standardization of valve threads for compressed gas cylinders, be the subject of a general conference of all interested groups to decide what action, if any, should be taken. In view of representations to the committee by representatives of the Compressed Gas Manufacturers' Association and the International Acetylene Association that the producers were not at present prepared to enter into such an undertaking, the committee decided not to call such a conference at the present time. This action is in accordance with the general policy of the American Engineering Standards Committee that it is not, itself, an initiating body, and that work is undertaken under its auspices only when industry is sufficiently favorable to make it certain that standardization can be effected.

The value of products manufactured in Detroit increased from \$400,000,000 in 1914 to \$1,500,000,000 in 1923. One-half of the 1923 production consisted of motor vehicles and parts for automobiles, trucks, and tractors.

# Jigs for Irregular-shaped Automobile Parts

By J. GUSTAF MOOHL, Chief Tool Engineer, Cleveland Automobile Co., Cleveland, Ohio

THE designing of jigs and fixtures for supporting castings of irregular contour during various operations involves some difficult problems. This is particularly true if the part has many rounded surfaces or projecting arms. How the problem of holding several irregular-shaped parts in jigs was solved by the engineering department of the Cleveland Automobile Co., Cleveland, Ohio, will be described in this article. The examples include jigs used in boring two holes and facing a boss of the flywheel housing; in boring the camshaft and crankshaft bearings in the crankcase; and in drilling the spark plug holes in the cylinder head. In connection with these operations, an ingenious method of feeding the facing tool is employed, as well as unusual methods of locating the casting, which will be referred to later.

The irregularity of the flywheel housing made it a difficult piece to support, as will be apparent from studying the construction of the jig illustrated in Figs. 1 and 2. The outline of the work is indicated in Fig. 2 by heavy dot-and-dash lines. The casting is slid into the jig on hardened steel strips *A* (see Fig. 1) until it contacts with two buttons *B* at the back. Then levers *C* are operated to raise pins *D* and lift the casting until the top comes in contact with the three buttons at *E*. In this way, the casting is located for height.

Levers *C* are each mounted on a shaft *F*, which is threaded where it extends through nut *G*. Hence, as the shaft is turned it screws in or out of the jig, depending upon the direction in which it is revolved. At the inner end of shaft *F* is mounted a wedge-shaped piece *H*, Fig. 2, which contacts with a similar shaped surface on the lower end of pin *D*. Consequently when shafts *F* are screwed into the jig, pins *D* are raised, and when the shafts are screwed out, the pins drop due to the weight of the work.

When the work has been located for height as explained, clamps *J* are slid in front of the casting and their nuts tightened just enough to hold the clamps in place. Then lever *K* is operated, forcing plungers *L* and *M*, Fig. 1, against the ends of the casting, and thus centralizing it lengthwise in the jig. A similar mechanism was illustrated in Fig. 1 of the article "Automotive Jigs that Save Time," which appeared on page 640 of April MACHINERY. The method of locking lever *K* in place after the casting has been located

was also explained, and therefore need not be described here.

Handles *C* are next turned slightly, and the nut of clamps *J* advanced to clamp the work at four different points. Plunger *N* is then lowered on a lug of the flywheel housing by releasing thumb-screw *O*, a coil spring forcing the plunger down. At the end of an operation, this plunger is raised by simply letting the casting pivot on plungers *D* and pressing down on the front of the casting, at the same time tightening up on thumb-screw *O*. Plunger *N* supports the casting close to the point where the facing tool is applied. Support *P* is next swung upward and tightened against the casting

to hold it firmly at the front of the jig, after which links *Q* are raised into contact with two surfaces, as shown, by raising pins *R*. This is accomplished by turning handles *T*, which feed shafts *U*, Fig. 2, transversely into the jig. At the rear end of shafts *U* there is a wedge-shaped surface that engages a corresponding surface on the bottom end of pin *R*, the mechanisms functioning in much the same way as those used for raising pins *D*. In spite of the number of adjustments made in loading this jig, the average reloading time is only 53 seconds.

Two boring-bars are used with this jig for finishing two holes, one of which is 4 5/8 inches in diameter by 3/8 inch

long, and the other 3 5/8 inches in diameter by 3/8 inch long, the smaller hole being bored first. The operation is performed under a radial drilling machine which obviates the necessity of shifting the jig for the two steps. Kelly boring-bars are employed, both bars being fed through bushing *V* and having a pilot that enters the bore of gear *W*. A key on the pilot enters a keyway in the gear, thus driving the latter, which, in turn, through an idler gear, drives a ring gear attached to the circular table *X*. On this table there is a slide that carries the facing tool *Y*, Fig. 1, the slide being attached to lever *Z*, which is fulcrumed on the table.

As the boring-bar for the large hole feeds down, the pilot of the bar contacts with a ball *A*, on lever *Z*, swinging the lever and thus causing the forward end to feed the tool-slide radially for facing the work. The surface faced is 9 1/2 inches outside diameter and 1 inch wide. The lower end of the boring-bar is fitted with a hardened steel plug so as to reduce wear at the point of contact with ball *A*,

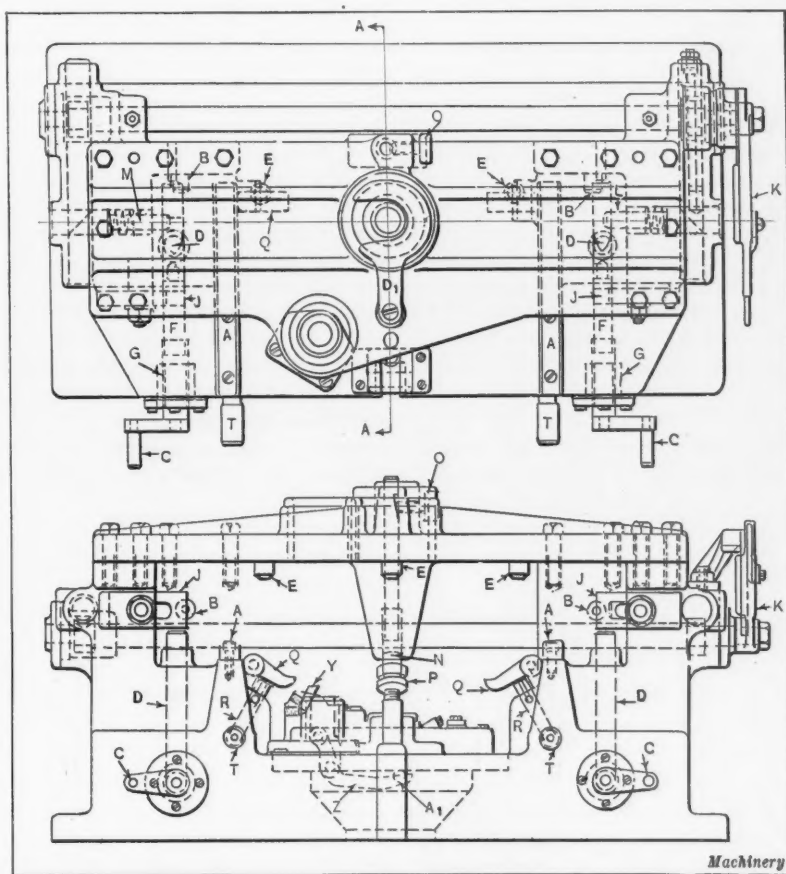


Fig. 1. Jig employed in boring and milling an Automobile Flywheel Housing



Machinery

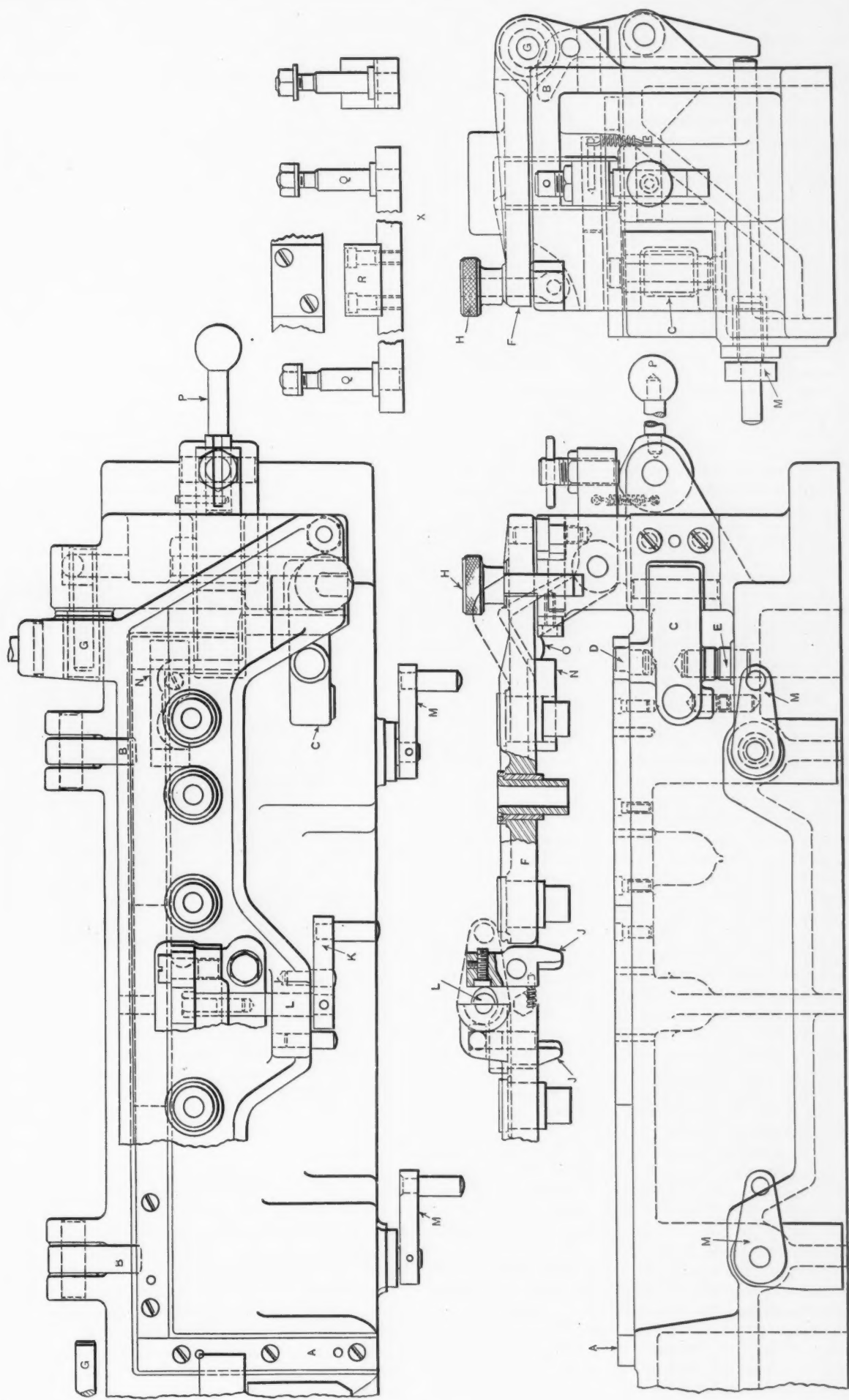


Fig. 4. Cylinder Head Jig having a Number of Unusual Features for locating, supporting, and clamping the Casting

row opening in the cylinder deck of the crankcase. In addition to these bearings, the boring-bars are supported and aligned in bearings at each end of the jig body. The operation for which this jig is used is performed on a Rockford two-way horizontal boring machine equipped with Kelly boring-bars.

Supports *A* are hardened and ground at *B* where they seat in a counterbore of the jig body, and at *C* where they bear against a hardened washer. Shank *D* is comparatively long and runs in a hardened bushing, thus firmly supporting the boring-bars. Adjusting nuts *E* engage threads on the rear end of the shank to take up wear. Two holes are drilled in the periphery of the supports, 90 degrees apart, to receive the indexing pin *F*. Before indexing a support, the pin is raised from the hole by means of lever *G*. The boring-bars extend through bearings *H* and *J*, which are equipped with hardened and ground steel bushings.

In loading the crankcase, two holes previously drilled and reamed are positioned on dowels *K*, and then four clamps *M* are tightened to hold the casting to the rear wall of the jig. Two spring pins *N* are next held firmly against a flange of the casting to eliminate chatter, by tightening screws *Q*. Three spring pins *O*, on which the casting seats along the front side, are then locked in place by tightening screws *P*. The loading of this jig requires 6½ minutes, but as the machine is equipped with two jigs mounted on an indexing base, reloading of the idle jig is accomplished while an operation is in progress, and so there is no loss of time. The crankcase is an iron casting. Section *X-X* clearly shows the construction of clamps *M*.

#### Interesting Centralizing Mechanism

The jig used in drilling the spark plug holes in the cylinder head is shown in Fig. 4. In loading this jig, the left-hand end of the cylinder head is slid into place while resting on the hardened and ground steel strip *A*, the right-hand end being supported by the operator until the casting strikes clamps *B* at the back. Then arm *C* is swung into the position shown. In the top of this arm is a hardened plug *D*, on which the right-hand end of the casting rests. A similar plug on the under side of the arm seats on plug *E*, this arrangement insuring a rigid support of the casting against the thrust of the drills. Arm *C* is required on account of the fact that the water-cooling manifold projects several inches below the surfaces on which the head is supported. Of course, the rear portion of the right-hand end also rests on strips located in the same plane as those on the left-hand end.

Jig plate *F*, which pivots on shafts *G*, is next lowered on the jig and held in place by means of two swing bolts *H*. The jig plate contains two fingers *J* which are swung toward each other at their lower end by turning handle *K*. This handle is mounted on the outer end of shaft *L*, which also carries a two-lobed cam bearing against a hardened button in the upper end of each finger. Hence, when handle *K* is operated 180 degrees, after a casting has been placed in the jig, the lower ends of the fingers swing toward each other. In doing this they grip the walls of the combustion chamber at the middle of the cylinder head and pull the head central lengthwise in the jig.

Two levers *M* are next turned to actuate transverse screws that bear against the lower end of clamps *B*. These clamps force the cylinder head toward the front of the jig and against a stop-plate *N* fastened near each end of the jig plate. By means of these devices and fingers *J*, the casting is located entirely from the jig plate. Finally the head is clamped firmly on the hardened and ground strips of the base by means of two clamps *O* which are operated by pushing handles *P* down. The construction and operation of this type of clamping mechanism was described in the article previously referred to. Standard interchangeable bushings are provided in this jig plate, the bushings extending down into the combustion chamber to within 1/4 inch of the work. This clearance permits chips to rise out of the holes being drilled without entering the bushings. The front side of the

jig base is of a sloping construction, so that the chips slide by gravity from the jig. The average reloading time is 14.4 seconds.

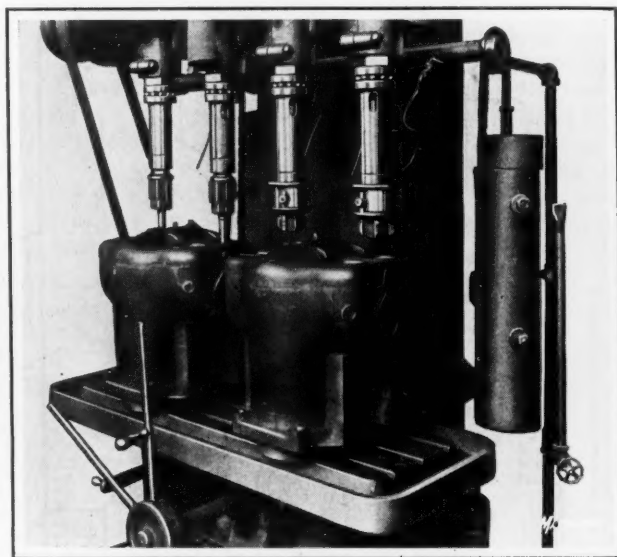
#### Gage for Setting the Centralizing Fingers

At *X* in Fig. 4 is shown a gage used occasionally for checking the accuracy of the centralizing fingers *J*. This gage is equipped with two vertical bolts *Q* which are used in the end bushings of the jig plate for clamping the gage to the under side of the plate in preparing for an inspection. The hardened and ground steel block *R* then projects upward between fingers *J*, and these should both touch the block when handle *K* is turned. The adjusting screws in fingers *J* may then be advanced or withdrawn to adjust the position of the hardened disk that contacts with the cam on shaft *L*. When the disk in each finger has been so positioned that both fingers touch the block, the adjusting screws are locked in place by means of the short headless set-screw.

\* \* \*

### A REAMING AND TAPPING OPERATION

In machining two-cylinder blocks for motor-boat engines at the Sterling Engine Co., Buffalo, N. Y., it is necessary to ream and tap two valve holes accurately with respect to the center distance. The holes are tapped 2 7/8 inches in diameter with 14 threads per inch. Both operations are performed under a four-spindle gang drilling machine, as may be seen from the illustration. A finished surface of the



Reaming and Tapping Two Holes in a Cylinder Block

block is simply seated on the table. The reamers are properly aligned for the operation by pilots which enter valve-guide holes that have been previously machined, and the taps follow the reamed holes. Each reamer actually consists of two tools for finishing two different diameters. Collapsing taps are employed.

\* \* \*

Increased attention is being directed to sales promotion, sales research and statistics, and sales training, according to the survey just completed by the Policyholders' Service Bureau of the Metropolitan Life Insurance Co. "Tendencies in Sales Organization," the third management leaflet published by this company, describes the organization and functions of sales organizations in such nationally known companies as the American Radiator, the Fuller Brush, the Elliot-Fischer, and the Burroughs Adding Machine companies. A comprehensive chart on the last page gives the outline of these organizations at a glance. Any interested executive may obtain a copy by writing to the Policyholders' Service Bureau of the Metropolitan Life Insurance Co., New York City.

# Letters on Practical Subjects



## WORK-LOCATING POINTS FOR FIXTURES

In order to produce an efficient jig or fixture, it is necessary that the locating points for the work be carefully selected. Whenever possible, these points should be finished surfaces, but for the first operation on castings, it is, of course, necessary to locate the work from a rough surface. Two three-point methods of locating work are shown by the views in the upper left-hand corner of the accompanying illustration. The view at the left shows the method used in locating pieces of rectangular shape, the pins *A*, *B*, and *C* being used as stops, against which the work *D* is clamped by pressure exerted in the direction by arrow *E*, or by two separate clamps, one acting in a vertical direction and the other in a horizontal direction. In the view at the right, the part *F* is clamped against the stops *H* and *J* by pressure exerted in the direction indicated by arrow *G*. This pressure may be applied by a screw or other clamping means.

In the lower left-hand corner of the illustration is shown in dot-and-dash lines a partial plan view and front view of a part located by an end-stop, two side-stops, and three bottom locating pins. The clamp *K* forces the work *L* against the stop *M* while the operator holds the work square against the two stop-pins *N* and *P*, or while another clamp, similar to the one shown at *K*, presses the work against stops *N* and *P* from the front side.

The stops used for locating the work in this case are all beveled and have their contact faces corrugated so that, in clamping, the tendency is to force the work down against the pins *R*, *Q*, and *S*, which provide a three-point bearing. The advantage of a three-point bearing is that it prevents the work from rocking, and it is obvious that three fixed stops like the ones shown at *M*, *N*, and *P* in combination with three locating pins like those shown at *Q*, *R*, and *S* provide the maximum number of fixed points that can be employed effectively in most cases. Other units designed

for clamping or supporting the work should be of an adjustable type, employing either an adjusting wedge, a screw, or a spring pin like the one shown at *Y* in the upper right-hand corner of the illustration.

Referring to the partial section views of the fixture in the upper right-hand corner, the work *T* is clamped against a screw *U*, and back against screws *V* and *W* by clamps or other means. The work is supported by the three fixed screws *X*, and after being clamped in place, the three spring pins *Y* are released and allowed to come into contact with the work. These pins are then clamped in position by a set-screw *Z*, which forces the stop-pin against the beveled surface of the spring pins *Y*. The locating screws *U* are provided with check-nuts, which are tightened to hold the screws in place after they have been properly adjusted. This method of locating and holding work is particularly adapted for castings of large size that require accurate positioning, and for thin-sectioned or frame-like castings.

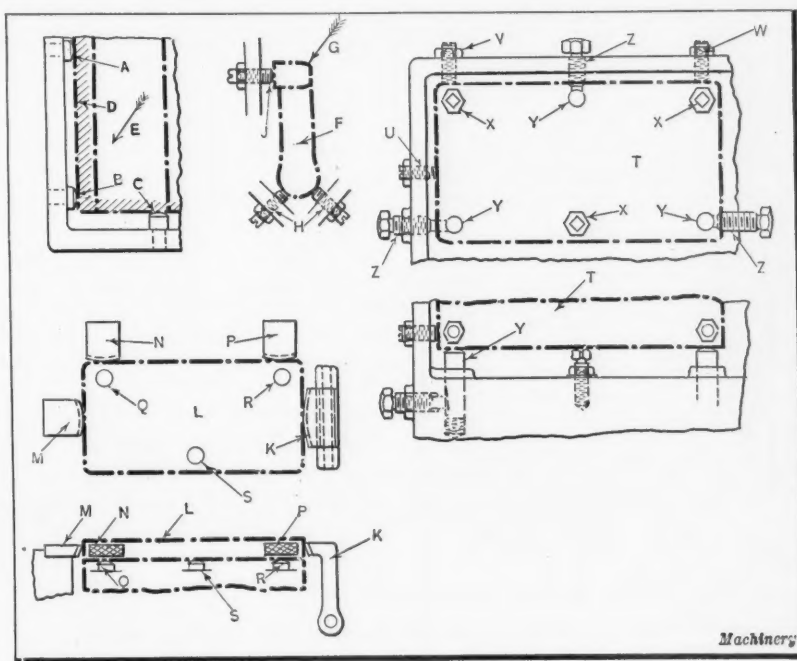
Holyoke, Mass.

FRANK H. MAYO

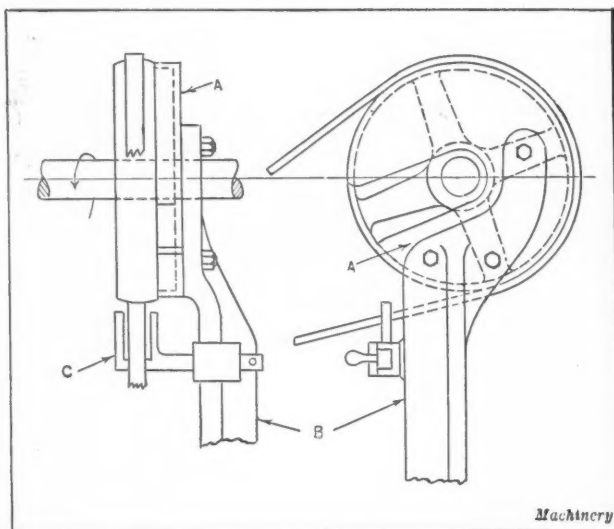
## LINESHAFT DRIVE WITHOUT CLUTCH

A method of driving a machine directly from a lineshaft without using a friction clutch or loose pulley is shown in the accompanying illustration. This method is being used successfully for driving light drill presses located at the

sides of a long bench. The drive shaft is supported by brackets mounted along the center of the bench. Each drill is driven from a tight pulley on the shaft, and at the side of each pulley is a stationary or dummy pulley such as shown at *A*. The dummy pulleys are machined from castings and have the same general shape as the driving pulleys except that an opening extends from one side to the center which permits them to be slipped over the shaft when being installed at the side of a tight pulley.



Different Methods of locating Work



Dummy Pulley used in Place of Loose Pulley

The dummy pulley does not touch the shaft but is fastened rigidly to a cast-iron bracket *B*, which, in turn, is secured to the bench. A belt-shifting fork *C* is fastened to the bracket which is used to throw the belt from the tight to the dummy pulley or vice versa.

At first it might appear that the method of shifting the belt is not practical, because it is stationary when on the dummy pulley. It has been found, however, that it is necessary to move the belt only a slight distance to give it sufficient gripping power on the revolving pulley so that it can be swung on the revolving pulley in the usual manner. The reverse operation of shifting the belt from the revolving pulley to the stationary or dummy pulley can also be readily accomplished.

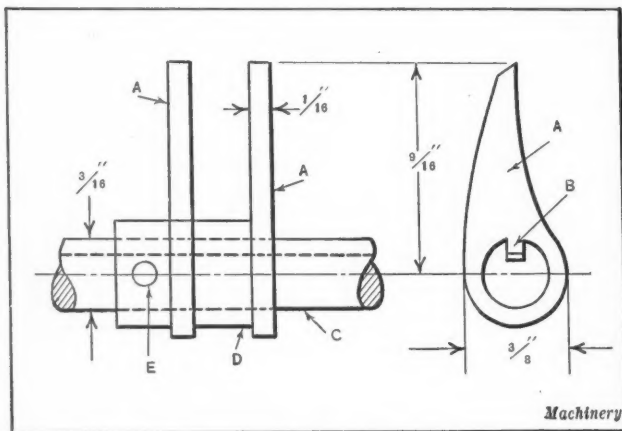
In the installations referred to, 1/2-inch belts were employed, but there is no doubt in the writer's mind that the same method could be used with satisfactory results for heavier drives. The method of driving from the lineshaft as described has the advantage of being cheaper than drives employing friction clutches, and it requires no oiling or other attention.

South Attleboro, Mass.

EARL R. PHINNEY

### KEYING AND SPACING PAWLS

The accompanying illustration shows a method of keying and spacing pawls or similar parts on a shaft. The method has proved practical and was used with satisfactory results in building a model machine. This job presented a problem of more than ordinary difficulty, it being necessary to fix ninety-six pawls in alignment and space them 1/4 inch apart on a shaft only 3/16 inch in diameter. The die used to punch out the pawls *A* from the sheet metal was designed to leave a key or projecting tongue at *B*. Shaft *C* was slotted



Method of keying and spacing Pawls on Small Shaft

the entire length, the slot being a close sliding fit for the pawl key.

Spacing of the pawls was accomplished by using collars like the one shown at *D*. The ninety-six pawls with the collars between them were assembled and pressed close together, after which they were fastened in place by pins *E* which passed through holes drilled through the shaft and collars. The projecting keys on the pawls serve to align the pawls and hold them firmly in place. The collars *D* were ground accurately to length, thus insuring even spacing.

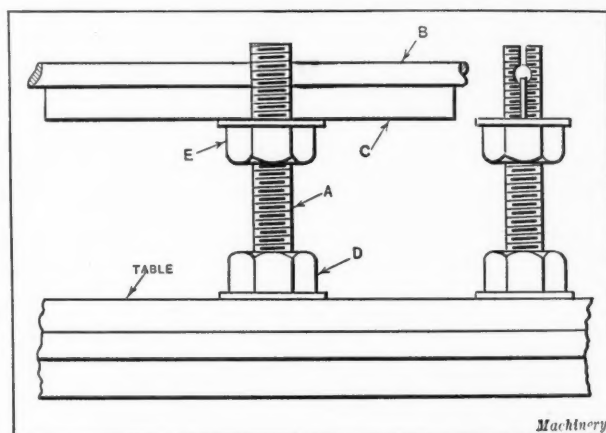
Pawtucket, R. I.

S. W. BROWN

### MILLING KEYWAYS IN SMALL RODS

A method of eliminating chatter when keyways are being milled in slender shafts or rods is to use supports like the one shown in the illustration. This design was developed primarily for use in milling the keyways in a lot of rods 3/8 inch in diameter by 2 feet long. The keyways were cut in both sides of these rods for nearly their full length.

The rods were simply pieces cut off to length from bar stock, and were not finished or machined on the outside previous to the keyway milling operations. They had small holes through the center, however, and this feature, together with the fact that there were slight bends in the pieces, made it necessary to provide some rigid means of holding the rods while milling the keyways, which would also



Work Support used while milling Keyways in Small Rods

straighten out the bends. The chief requirement was that the keyways should be of uniform depth and located diametrically opposite each other.

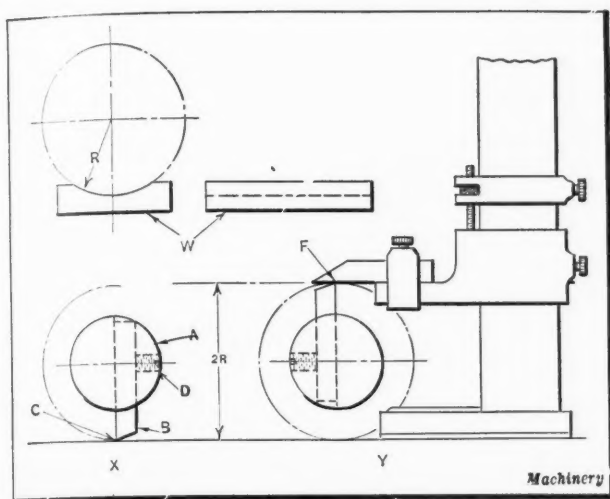
The support consists of a T-bolt *A*, drilled to receive the rod *B* in which the keyway is to be cut, clamping nuts *D* and *E*, and supporting strip *C*. The work *B* is pushed first through the chuck jaws on the dividing head and then through the hole in holder *A*. The outer end is supported by the tailstock center, while the other end is held in the chuck jaws. The strip of stock *C* is then put in place as shown, and nut *E* tightened, thus securing the work rigidly in place. After milling the keyway on one side, the clamping nut *E* is loosened, the work indexed half a revolution, and strip *C* clamped against the bottom of the keyways by tightening nut *E*; the second keyway is then milled.

Montreal, Canada

NORMAN MOORE

### SETTING FLY CUTTER TO EXACT RADIUS

Almost every man engaged in machine shop work has occasion to use the milling machine for machining work to a given radius with a fly cutter. Generally the set-up is simple, the fly cutter holder being held in the spindle of the machine and the work gripped in a vise or strapped to the table. The "cut-and-try" method used by most workmen when setting the cutter to the required radius prompts the writer to submit the following method which has proved accurate and convenient.



Method of setting Fly Cutter to Exact Radius

Referring to the accompanying illustration,  $R$  represents the radius of the surface to be cut in the work  $W$ . In the lower view, the cutter  $B$  is shown mounted in its holder in the proper position for machining the work to the required radius. In setting the cutter, it is first located in approximately the correct position, after which the gears that drive the machine spindle are disengaged to permit the bar  $A$  to be revolved by hand. The next step is to raise the table until cutter  $B$  is in contact with the upper surface at the point of tangency  $C$ . The cutter-holder or bar  $A$  is then rotated 90 degrees, as shown in the view at the lower right-hand corner of the illustration, and the measurement taken from point  $C$  to the point  $F$  of the tool.

Assuming that the required diameter  $2R$  equals 2 inches and that the measurement from point  $C$  to point  $F$  is  $2\frac{1}{8}$  inches, it is apparent that the tool projects  $1/16$  inch beyond the correct position. The correct setting of the tool can now be obtained in the following manner: First, raise the table of the milling machine 0.062 inch and loosen the set-screw  $D$ . Next turn bar  $A$  through an angle of 90 degrees so that the point of the tool  $B$  is again in contact with the upper surface of the table, and tighten the set-screw  $D$ .

Newport News, Va.

H. H. MORRIS

## DETERMINING THE RADIUS OF A SEGMENT

The method of determining the radius of a segment described in the following can be used to find the diameter of a broken disk when only a fragment of the disk is available for measuring. This method can also be used in checking the diameter of gages, dies, segments of a gear like the one shown at  $A$  in Fig. 1, or spherical gages like the one shown at  $B$ . The first step is to place the work to be gaged on a surface plate, as indicated in Fig. 2. Two rolls, 0.500 inch in diameter, are then placed in contact with the work and

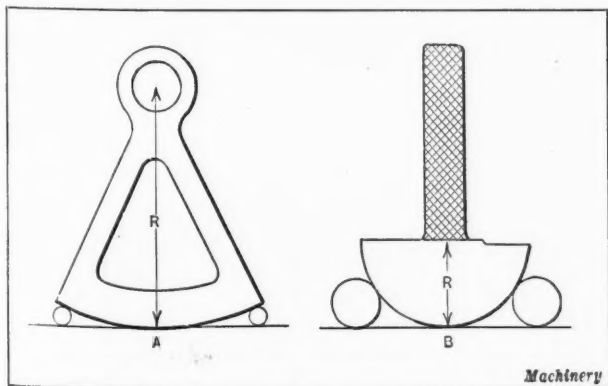


Fig. 1. Gages checked by Roll Method

with the surface plate, as shown, and the micrometer reading is taken over these rolls. In this case, the reading was 3.1724, as indicated in the illustration.

Now we have radius  $R$  equal to  $OE$ , and  $OE$  perpendicular to the line  $MN$ . Next construct the triangle  $OBC$ , drawing  $BC$  through the center of the roll parallel to  $MN$ . The problem is to find the length of  $OE$ . By hypotheses we have

$$OB = R - 0.250, OC = R + 0.250, BC = \frac{3.1724}{2} - 0.250 = 1.3362.$$

In triangle  $OBC$  we have  $OC^2 = OB^2 + BC^2$ .

Substituting,

$$(R + 0.250)^2 = (R - 0.250)^2 + (1.3362)^2$$

Squaring,

$$R^2 + 0.500R + 0.0625 = R^2 - 0.500R + 0.0625 + 1.7854$$

Cancelling,

$$R = 1.7854 = OE$$

Then the diameter equals  $2 \times 1.7854 = 3.5708$  inches.

The following formulas derived from the algebraic solution involve only arithmetical calculations and can be employed by those who do not have a knowledge of algebra.

1. Use rolls 0.500 inch in diameter and divide the mi-

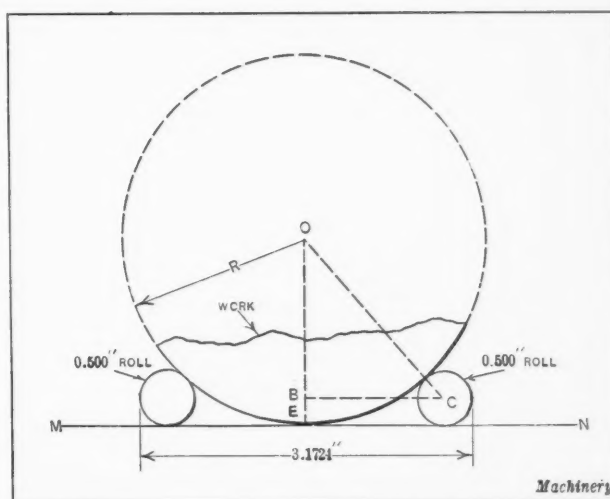


Fig. 2. Method of obtaining Measurement for determining Diameter of Broken Disk

cro-meter reading by 2. From this, subtract 0.250 and square the result. Using this rule for the foregoing example, we have:

$$R = \left( \frac{3.1724}{2} - 0.250 \right)^2 = 1.7854$$

2. Using rolls 0.400 inch in diameter, divide the micrometer reading by 2 and subtract 0.200 inch. Next square the result and divide by 0.8. Expressed as a formula,

$$R = \frac{(\text{micrometer reading} \div 2 - 0.200)^2}{0.8}$$

3. Using rolls 0.300 inch in diameter,

$$R = \frac{(\text{micrometer reading} \div 2 - 0.150)^2}{0.6}$$

4. If the work to be gaged is very large, rolls 1 inch in diameter should be used, in which case the diameter can be found directly by the formula

$$R = \left( \frac{\text{micrometer reading}}{2} - 0.500 \right)^2$$

5. For any size rolls or wires,

$$R = \frac{(\text{micrometer reading} \div 2 - \text{half of one roll})^2}{2 \times \text{size of one roll}}$$

South Bend, Ind.

J. A. PORATH

TABLE SHOWING AMOUNT AND COST OF WASTE FROM OPEN VALVES OR LEAKS

Diameter of Waste Opening, Inch	Air		Steam		Water		Gas	
	Pressure, 100 Pounds per Square Inch		Pressure, 100 Pounds per Square Inch		Pressure, 40 Pounds per Square Inch		Pressure, 4 Inches Water Column	
	Number of Cubic Feet Wasted per Month	Cost per Month at 10 Cents per 1000 Cubic Feet	Number of Pounds Wasted per Month	Cost per Month at \$1.00 per 1000 Pounds	Number of Gallons Wasted per Month	Cost per Month at 9 1/2 Cents per 1000 Gallons	Number of Cubic Feet Wasted per Month	Cost per Month at 50 Cents per 1000 Cubic Feet
1/2	17,800,000	\$1780.00	805,500	\$805.50	1,250,000	\$119.00	141,000	\$70.50
3/8	9,980,000	998.00	462,000	462.00	692,700	65.80	79,100	39.55
1/4	4,450,000	445.00	203,500	203.50	308,000	29.26	35,300	17.65
1/8	1,114,800	111.48	56,000	56.00	77,000	7.31	8,850	4.42
1/16	278,700	27.87	13,000	13.00	19,500	1.85	2,210	1.10
1/32	69,850	6.98	3,200	3.20	4,900	0.46	550	0.27

Machinery

WASTE RESULTING FROM OPEN VALVES OR LEAKS

The accompanying table shows the results of extensive tests made at one plant to determine the amount of waste caused by open valves or leaks. While the cost of the various materials may vary somewhat in different plants, the table can be easily changed to give the correct values for any plant. Probably few people realize the unnecessary waste of material and the expense resulting from carelessness in leaving valves open or in permitting leaks to go unrepaired. Examination of the table, however, will show that attention to such details may result in material savings.

Detroit, Mich.

J. H. CHEETHAM

SPECIAL BUSHINGS FOR DRILLING ACCURATELY SPACED HOLES

The writer has obtained very good results in drilling accurately positioned holes in such work as dies and drill jigs, by using special drill bushings like those shown in the accompanying illustration. The six bushings shown have holes in them ranging from 1/16 to 1/2 inch in diameter. These bushings are all hardened, and some of them are ground after hardening. In using the bushings, one hole is located and drilled, after which a pin is placed in the hole and one of the bushings set the proper distance from the center of the pin for drilling the next hole, by measuring with a micrometer in the manner indicated in the illustration. When the bushing has been properly located, it is clamped in place and the hole drilled and reamed in the usual manner.

With this method of locating and drilling holes, the accuracy obtained is equal to that obtained with the usual type of drill jig. The task of making a drill follow a center-punch mark is eliminated by this method, as well as the difficulty of making a center-punch mark at the exact intersection of the lay-out lines. While it is not claimed that

the method described is as accurate as the button method of drilling and boring in the lathe or milling machine, it is much quicker, and the writer has found it to be more accurate than any other method when the drilling is done on an ordinary drill press.

Philadelphia, Pa.

CHARLES KUGLER

LINK RADIUS MILLING FIXTURE

The fixture shown in the accompanying illustration is used for radius-milling locomotive links. It is so designed that it can be secured to the table of a milling machine in the manner shown, and can be adjusted for milling links of different radii. On the cast-iron body A of the fixture are mounted two guide rods B and C, which are pivoted at their inner ends on the stud D. The outer ends of these rods are clamped in place by studs which pass through the slots E and F.

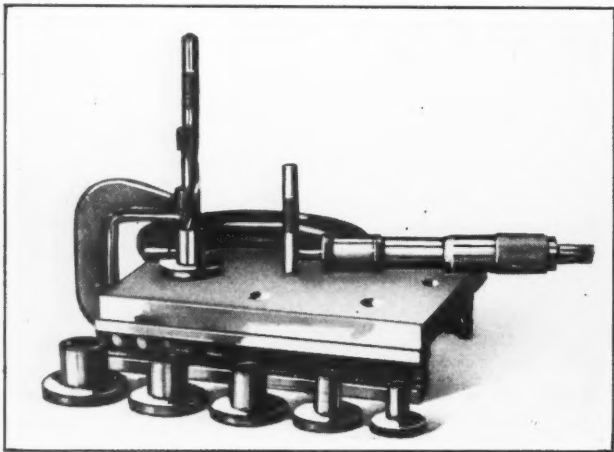
The link to be milled has holes drilled near each end which fit the pins G and H on the sliding blocks on guide rods B and C. The outer ends of the guide rods are adjusted to give the correct movement to the work, and are clamped in place by the bolts that pass through the slots E and F. By raising the ends of the guide rods, the work will be milled to a shorter radius. The screw J, which fits a threaded hole in the sliding block on rail C, serves as a means for feeding the work past the milling cutter. The handle K is used in setting up and adjusting the fixture, and is replaced by a worm-wheel driven from the milling machine table feed-screw when the radius-milling operation is performed.

Chattanooga, Tenn.

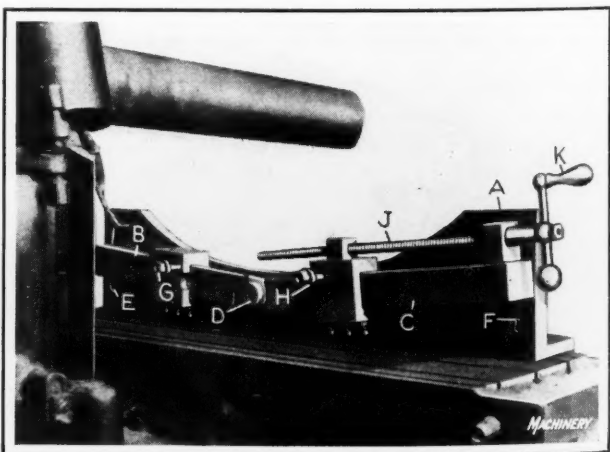
H. H. HENSON

\* \* \*

Automobile exports are increasing to a considerable extent and are about 50 per cent ahead of the exports of last year. The exports to practically all the European countries and Cuba have increased, Italy, Spain, and Denmark having been particularly active buyers.



Method of using Bushings for laying out and drilling Holes



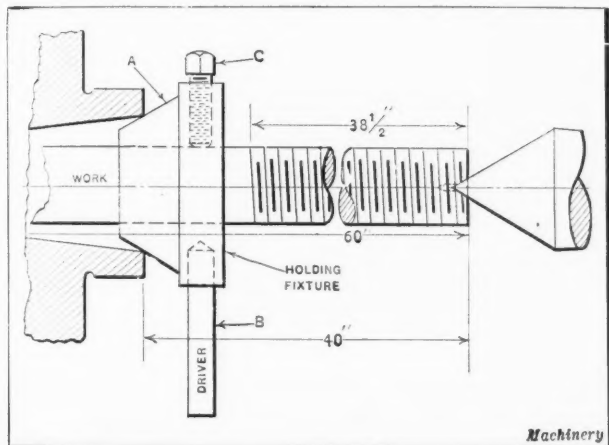
Fixture for radius-milling Locomotive Links

## Shop and Drafting-room Kinks

### CUTTING THREADS ON LONG BARS

Recently the writer found it necessary to thread the ends of a number of bars that were too long to be held between the lathe centers. The bars were centered at one end and the centered end of one bar passed through the spindle of the lathe. After gripping the bar in a collet chuck, the tail-stock center was adjusted to support the outer end of the work and the threading operation performed in the usual manner. This method proved unsuccessful, as the thread was found to be tapering for a distance of 4 or 5 inches, being from 0.001 to 0.004 inch too small at the small end of the tapered portion. As the thread was required to have no taper and to be very accurate, it was necessary to devise some more satisfactory method of holding the work during the threading operation.

In the accompanying illustration is shown the holding fixture finally devised. This simple fixture, which permitted the threading operation to be performed satisfactorily, consists of a conical shaped body A with a flange at the large



Method of holding Bar for Threading Operation

end, a driving rod B pressed into a radial hole in the flange, and a set-screw C which clamps the fixture to the work. The conical end of the member A serves to center the work in the hole in the lathe spindle.

Paterson, N. J.

S. COURTER

### PLACING INCH MARKS OVER A DECIMAL POINT

While the practice of placing inch marks over the decimal point is not a standard used by the drafting-rooms in all the departments of the Navy Yard at Portsmouth, Va., it is generally employed in making ordnance drawings at this yard, in cases where precision and accuracy are essential factors.

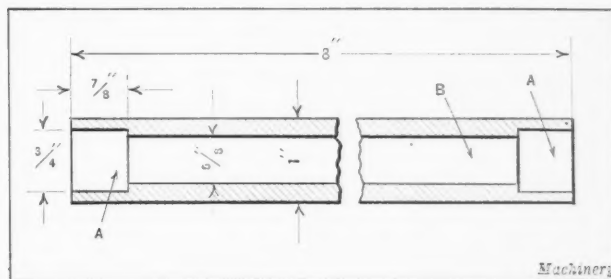
In putting down dimensions of whole numbers, the practice is to place the decimal point after the number. Now if we add a decimal fraction, why should it be necessary to move the inch marks? By having the inch marks over the decimal point they are always in the same relative position with respect to the whole number. In case the decimal point is accidentally erased, the inch marks being located between the figures and over the decimal point indicate at once just what the original number was intended to be. The writer believes that this practice would work out very well if established in all drafting-rooms and shops.

Portsmouth, Va.

R. S. MORECOCK

### MAKING MACHINE PARTS FROM TUBING

Sleeves, or similar machine parts that ordinarily require the drilling of a deep hole, may in many cases be produced more economically by using seamless steel tubing instead of



Part made from Steel Tubing

solid metal. Tubing may be obtained in such a variety of sizes that either the exact size required or a size suitable for finishing is usually available. By using tubing instead of bar steel the cost of seventy-two sleeves like the one shown in the illustration was cut 60 per cent. The outside diameter of the tubing was finished to size, and the holes A bored to receive bushings. The long clearance hole B was left unfinished, where formerly it had to be drilled through solid stock. The foregoing suggestion may be employed in some cases in making machine tool spindles, as these usually have long clearance holes.

Pawtucket, R. I.

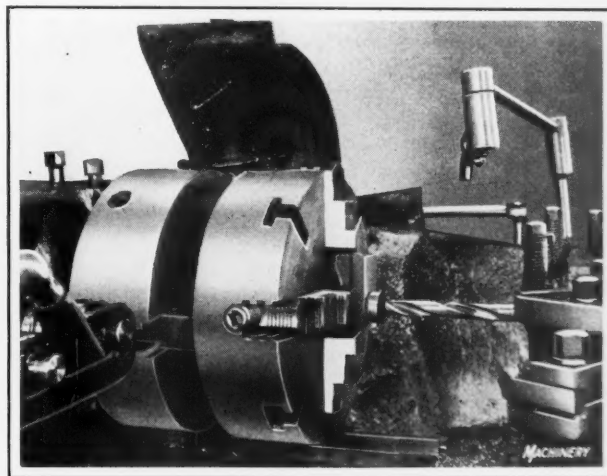
S. W. BROWN

### TANDEM CHUCK ARRANGEMENT FOR RUSH JOB

In handling rush jobs, delays are frequently caused by the necessity for changing chucks. Often it is impossible to find a suitable lathe that is equipped with the right kind of chuck. This difficulty can usually be overcome, however, by using a tandem arrangement of chucks, as shown in the illustration. In this case, a turret lathe was the ideal machine on which to finish the part, but the design of the work was such that it was necessary to hold it in a four-jaw chuck. As the turret lathe chuck was of the three-jaw type, the operator simply secured a four-jaw chuck and gripped it in the three-jaw chuck.

Springfield, Vt.

O. S. MARSHALL



Holding Work in Four-jaw Chuck gripped in Regular Chuck

## Questions and Answers

### OPEN-HEARTH TOOL STEEL

A. V.—To what extent is tool steel made by the open hearth process? What general classes of tools are made from open-hearth steel, and how does this steel compare with that made by the crucible and electric processes?

A.—A large percentage of the steel used for making tools, if all classes of tools are considered, is produced by the open-hearth process. Open-hearth tool steel, however, is not recommended ordinarily for metal-cutting tools; in fact, either crucible or electric tool steel is specified by practically all manufacturers whenever the use of a dependable high-carbon steel of the best quality is considered essential.

Open-hearth tool steel meets all requirements for a large variety of tools and implements which ordinarily are made from steels containing about 0.65 to 0.85 per cent carbon. These tools include hammers, sledges, pliers, woodworking tools, stone cutters' tools, picks, bars, axes, cheap knives, blacksmith tools, forging dies, agricultural implements, and numerous other products. The extensive use of open-hearth steel in the agricultural field accounts for the name "agricultural tool steel."

In attempting to make a direct comparison between steels made by the open-hearth process and either the crucible or electric process, it should be remembered that much depends upon the selection of raw materials and the care with which each process is conducted. Considering these steels as they are produced under ordinary commercial conditions, it is the general opinion of manufacturers that either crucible or electric steel is superior to open-hearth steel except for the general classes of tools mentioned, which are made from the relatively cheap open-hearth steel, as the latter meets all practical requirements. So far as we know, tests have never been made to determine definitely the relative service qualities of steels representing the very best that each of the three processes mentioned are capable of producing. This general question concerning the relative merits of these steels was submitted to several authorities in the steel industry, and the following replies throw some light upon the subject, although it is evident that there are differences of opinion concerning important points:

According to the metallurgical engineer of a prominent steel company, "either crucible or electric furnace steel is, generally speaking, superior in quality to basic or acid open-hearth steels, since the characteristics of these processes are particularly adaptable to the manufacture of a high-grade product. It would be entirely possible, however, to make basic and acid steel of a quality at least as good as crucible or electric furnace steel if the utmost care were not taken in the latter processes. This company has manufactured thousands of tons of basic open-hearth steel used for what might be termed the rougher tools in contradistinction with tools used for very fine work. Our steel is used for general machine shop tools, smiths', stone-cutters' and woodworking tools, and various agricultural implements."

The viewpoint of another authority is as follows: "Acid-lined open-hearth furnaces of from five to ten tons' capacity produce tool steel that it is impossible to distinguish, by any methods known to me, from crucible steel. In a small way the writer has tested such steel. Dies made with it perform as well as crucible tool steel dies. Notwithstanding this fact, we do not knowingly use open-hearth tool steel for dies. The reason we do not is that the cost of the steel, in relation to the labor cost of making the die, is usually small. Anything that might happen to the die would be laid immediately to the open-hearth steel. It is so difficult to trace effect back to cause, that it is usually cheaper to eliminate doubtful material from the start.

"To illustrate this point, a punch 8 inches in diameter and 36 inches long made of crucible tool steel (1.10 per cent carbon) did not harden properly even after three trials. If the punch had been made of open-hearth tool steel, it would probably have been condemned after the first failure to harden. Having confidence that the steel was not at fault, the quenching facilities were changed to include a large volume of water at high pressure, and the punch hardened all right.

"It would be interesting to know whether those who state that open-hearth tool steel is not as good as crucible tool steel, base their opinion on actual trials or on hearsay. Also, if based on actual trials, whether the open-hearth steel used was the very best that it is possible to obtain, or if it was the ordinary variety made in sixty-ton or larger, basic open-hearth furnaces. It is doubtful if the ordinary materials used in a basic open-hearth furnace would produce good tool steel if melted in a crucible, and it is quite certain that if the materials used in crucible tool steel manufacture were melted in open-hearth furnaces, better steel would be produced than from ordinary open-hearth materials. In order to study the effect of the melting process, materials of equal quality should be used in each process."

The representative of another steel company writes as follows: "In our opinion good tool steel cannot be made in small acid open-hearth furnaces. The reactions in the acid furnace make it extremely difficult to eliminate sulphur and phosphorus, and it is generally conceded that the lower the sulphur and phosphorus content, the better the tool steel. Although we cannot give the results of definite tests for comparing open-hearth tool steel with crucible steel, we have experienced many instances where our customers were not getting satisfactory results on carbon tool steel based on what they *thought* was crucible steel. Our laboratory investigation proved that they were not buying crucible steel, but were really getting a good grade of open-hearth steel. After obtaining an electric furnace steel, the trouble was eliminated.

"For heat-treating and uniformity, electric furnace steel is far superior to the best grade of open-hearth steel, and is fully the equal of crucible steel and usually more uniform. Open-hearth tool steel is used chiefly for what is termed agricultural tool steel, hand tools, such as chisels, hammers, axes, cheap knives, etc. Definite figures are not at hand concerning the percentage of open-hearth tool steel consumption, but it is our opinion that it would amount to nearly 95 per cent, provided all classes of tools were considered."

### CARBURIZING AND CASEHARDENING

J. A. P.—What is the difference, if any, between carburizing and casehardening?

A.—In order to harden low-carbon steel, it is necessary to increase the carbon content of the surface of the steel so that this thin outer "case" can be hardened by heating the steel to the hardening temperature and then quenching it. The process, therefore, involves two separate operations: First, the carburizing operation for impregnating the outer surface with sufficient carbon, and second, the heat-treating of the carburized parts so as to obtain a hard outer case and, at the same time, give the "core" the required physical properties. The term "casehardening" is ordinarily used to indicate the complete process of carburizing and hardening, but it is often applied to indicate the heat-treatment after carburization.

## Four Notable Machine Tool Exhibits

**D**URING the past weeks, four extensive and interesting exhibits of machinery and machine tools have been held in the United States. One was staged by the National Machinery Co. at its plant in Tiffin, Ohio, and comprised a complete exhibit of the different lines of bolt, nut, and forging machinery made by this company. The next to follow was an exhibit by Manning, Maxwell & Moore, Inc., in their Chicago salesrooms, of machines built by fourteen manufacturers represented by that company. The third exhibition was held in New Haven, Conn., under the auspices of the New Haven Local Section of the American Society of Mechanical Engineers, Yale University, and the New Haven Chamber of Commerce; and the fourth was held in conjunction with the annual convention of the American Society for Steel Treating at Cleveland, Ohio.

### The National Machinery Co.'s Exhibit

The exhibition of the National Machinery Co. was held Friday, August 21, and Monday, Tuesday, Wednesday, and Thursday, August 24 to 27. This exhibit was on an unusually large scale to be staged by one company. Altogether, sixty-two different machines were exhibited, many of which have recently been brought out or redesigned and which had not previously been announced to the mechanical field. Not less than twenty of these machines, including those of new design, were shown in operation under actual manufacturing conditions, and eleven machines were exhibited partially or wholly disassembled, with a view to showing their design and construction to the mechanical men attending the exhibit.

The smallest of the machines on exhibition was a 1/8-inch automatic nut-tapping machine, weighing only 125 pounds. The largest machine was a 5-inch heavy pattern forging machine, weighing 130,000 pounds. In addition to the bolt, nut, and forging machines, auxiliary equipment, consisting of furnaces, blowers, and electric heating devices, were also exhibited. An outstanding feature was the exhibit of a complete bolt and nut plant, operated on a production basis. A large number of forgings were also exhibited, showing the wide range and accuracy of work that is now being done by modern forging equipment. Some forgings are now made accurate within limits of plus or minus 0.001 inch.

General executives, shop executives, and engineers from many concerns using forging equipment in various fields attended the exhibit, including bolt and nut manufacturers, railroad shop men, and automobile builders. Almost every part of the United States was represented, the attendance reaching nearly 2000.

A visitor to the exhibition left it with this impression: "During recent years so many important developments have been made in forging methods and in the design of forging

machinery that only an exhibit of this kind could possibly bring out an adequate idea of what has been accomplished." Among the exhibits of new developments was a line of high-duty forging machines which will later be described in detail in the technical press.

At the time of the exhibit, the Railway Master Blacksmiths' Association was in convention in Cleveland, and the delegates to this convention accepted the National Machinery Co.'s invitation to visit Tiffin on August 21; that day was therefore set aside as Master Blacksmith's Day, the delegates being taken to Tiffin by special train. A special train was also run from Detroit on the closing day, August 27. While in Tiffin the visitors were the guests of the National Machinery Co.

### Manning, Maxwell & Moore's Exhibit in Chicago

A comprehensive exhibit of machine tools was held by Manning, Maxwell & Moore, Inc., in their salesrooms at 27-29 N. Jefferson St., Chicago, Ill., during the two weeks, August 31 to September 12, inclusive. At this exhibit machines of fourteen manufacturers represented by Manning, Maxwell & Moore were shown, operated under power by direct factory representatives. Most of these machines were engaged on work of particular interest to railroad men, the exhibit having been arranged to coincide with the conventions of the American Railway Tool Foremen's Association and the International Railway General Foremen's Association, both of which were held at Chicago, the former, September 2 to 4, and the latter, September 8 to 11.

### The New Haven Machine Tool Exhibition

The fifth annual New Haven machine tool exhibition was held September 8 to 11, the exhibits being arranged in the Mason Laboratory of the Sheffield Scientific School. In all, eighty-three machine tool, small tool and accessories manufacturers exhibited their products. Most of the machine tool exhibits were shown in operation. Practically all types of machine tools were represented, and a comprehensive idea of recent developments in machine tool design could be formed by an inspection of the exhibits.

In connection with the machine tool and accessory exhibition, technical sessions were held by the Machine Shop Practice Division of the American Society of Mechanical Engineers. A complete list of the papers read at these sessions was given on page 14 of September MACHINERY, and abstracts of the papers were published in that number.

### Steel Treaters' National Exhibit

What was doubtless the largest and most comprehensive exhibit of modern machine tools ever held was that staged



Looking down the Main Bay of the National Machinery Co.'s Forging Machinery Exhibition at Tiffin, Ohio

by the American Society for Steel Treating in conjunction with its seventh annual convention held in Cleveland, September 14 to 18. The exhibition was arranged in the new Public Auditorium in Cleveland, a building unusually well suited for the purpose. Both the main floor and the lower floor were entirely given up to exhibits and every available space was filled, a great number of prospective exhibitors having been unable to secure space. In all, there were over 180 exhibits, of which nearly 100 were in the machine tool and small tool fields.

The entire lower floor was devoted to the machine tool exhibition. Practically every exhibit was shown under power, and actual production work was being performed. One of the visitors stated that the exhibition presented one of the busiest machine shops that he had ever seen, while another expressed his idea of the exhibit by saying that it was the best equipped machine tool shop in the world. There is no doubt about the latter statement, because never before has such an aggregation of modern developments in machine tool design been shown under one roof.

In connection with the exhibit, the American Society for Steel Treating held its technical sessions each morning and afternoon. Thirty-four papers were presented dealing with almost every phase of the metallurgy, heat-treatment and testing of steel. The Production Meeting of the Society of Automotive Engineers was held in Cleveland during the same week, and the Machine Shop Practice Division of the American Society of Mechanical Engineers also held a session, at which two papers were read, one on "Modern Surface Grinding," by H. K. Spencer of the Blanchard Machine Co., Cambridge, Mass., and the other on "The Use of Machinery in Making Dies for Sheet-metal Work and Forgings," by S. A. Keller, of the Keller Mechanical Engineering Corporation, Brooklyn, N. Y. These papers are referred to on page 146 in this number of MACHINERY.

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#### AVAILABLE WATER POWER

The total capacity of water wheels and turbines in the United States, installed in plants of 100 horsepower or more up to March, 1925, was over 10,000,000 horsepower, an increase of over 950,000 horsepower, or over 10 per cent, since March, 1924. Of this increase, 99 per cent is in public utility power plants and only 1 per cent in individual manufacturing plants. It is estimated that the total water power in the United States, available 90 per cent of the time, amounts to nearly 35,000,000 horsepower, and that available 50 per cent of the time is over 55,000,000 horsepower. Of this water power, nearly 40 per cent is available in the Pacific states and about 30 per cent in the Mountain states. Washington ranks first with over 14 per cent of the available water power, California coming next with from 12 to 13 per cent; next in order come Oregon and New York. Of the developed water power in the United States, the Pacific states have 23 per cent, the middle Atlantic states, 19 per cent, the south Atlantic states, 16 per cent, and the New England states, 14 per cent.

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#### MEETING OF RAILWAY TOOL FOREMEN

At the convention of the American Railway Tool Foremen's Association held early in September in Chicago, 120 members representing about 50 railroads were present. There was a large and interesting exhibit of modern portable and stationary machine tools for railroad shops. Officers were elected for the year 1925-1926 as follows: President, E. A. Hildebrandt, Cleveland, Cincinnati, Chicago & St. Louis Railway Co., Indianapolis, Ind.; first vice-president, O. D. Kinsey, Chicago, Milwaukee & St. Paul Railway, Milwaukee, Wis.; second vice-president, E. A. Greame, Delaware, Lackawanna & Western Railroad Co., Scranton, Pa.; third vice-president, W. R. Millican, Missouri-Kansas-Texas Railroad Co., Parsons, Kan.; secretary-treasurer, G. G. Macina, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

#### AUTOMOTIVE ENGINEERS' PRODUCTION MEETING

The Production Meeting of the Society of Automotive Engineers, held in Cleveland September 14, 15, and 16, simultaneously with the annual meeting of the American Society for Steel Treating and the National Steel Exposition, was unusually well attended, and the papers presented were of remarkable interest, both to automotive engineers and to machine tool builders. As might be expected, the larger number of those in attendance were automotive production men. A number of machine tool builders were also represented, as well as the National Machine Tool Builders' Association, through its general manager, Ernest F. DuBrul. It would doubtless be of great benefit to the machine tool industry if a larger number of engineers and designers in the machine tool field were present at these production meetings, for the value of the exchange of ideas cannot be overestimated.

Six sessions were held during the three days of the meeting, two machine tool sessions, one session pertaining to inspection, one to gear production, one to training, and one to sheet-steel production.

##### The Machine Tool Sessions

At the machine tool sessions six papers were presented as follows: "Machine Tool Needs of the Automotive Industry," by R. M. Hidey of the White Motor Co.; "Machine Tool Selection," by W. G. Careins of the Ajax Motors Co.; "Drill Press Applications," by R. M. Anderson of the Holley Carburetor Co.; "Analysis of Machine Tool Maintenance," by A. R. Kelso of the Continental Motors Corporation; "Jigs and Fixtures in Automotive Production," by J. Gustaf Moohl of the Cleveland Automobile Co.; and "Making Machine Tools Safe," by R. F. Thalner of the Buick Motor Co.

Mr. Hidey's paper on "Machine Tool Needs of the Automotive Industry," abstracted on page 107 of this number of MACHINERY, created a great deal of discussion, A. C. Cook of the Warner & Swasey Co., Ernest F. DuBrul of the National Machine Tool Builders' Association, and Forrest E. Cardullo of the G. A. Gray Co., presenting, among others, the machine tool builders' point of view on this subject. Equally interesting discussions also followed Mr. Careins' paper on machine tool selection, Mr. Moohl's presentation of the subject of jigs and fixtures, and Mr. Thalner's address on safety in the machine shop, all of which will be more completely reviewed in a coming number of MACHINERY.

The analysis of machine tool maintenance, by Mr. Kelso, contained carefully made tabulations of maintenance and repairs required in different types of machine tools. This paper will also be abstracted in a coming number of MACHINERY. The paper on drill press applications, by Mr. Anderson, was illustrated with lantern slides, showing clearly the different steps used in producing carburetor parts.

##### The Gear Production Session

At the session dealing with gear production problems, a paper was presented by P. L. Tenney, Muncie Products Division of the General Motors Co., on "Coordinating Designs and Production Methods in Gear Development." This paper outlined, step by step, the methods of investigation that have been used for determining the best processes for producing quiet gears with satisfactory wearing qualities. These investigations indicate that every item entering into gear production, especially the kind of steel used, its heat-treatment, the tooth form, the mathematics of the gear action, and the methods of cutting the gears, has to be considered with equal care.

Tests were made on practically the entire group of chrome-carbon, chrome-manganese, manganese-molybdenum, chrome-nickel and chrome-vanadium steels, using lead pots, salt baths, cyanide and electric furnace methods of heat-treatment. The outstanding features of these tests were the high wear-value of cyanide-treated chrome steel, and the even

better value of chrome-vanadium steel when cyanide-treated. A study of the characteristics of the wear of gears resulted in a reduction of 20 per cent in the weight of the transmission for a given power-transmitting capacity.

The paper indicated how by the fullest cooperation between the steel mill, the forge shop, the heat-treating and metallurgical departments, the machine tool builder, the grinding wheel manufacturer, and the engineering department, some very intricate production problems can be solved. Gear noise can be eliminated to a great extent, and a much improved product can be obtained, in most instances, at a lower cost.

Earle Buckingham, of the Niles-Bement-Pond Co., presented a paper on "The Problem of Gear Production," an abstract of which will be found on page 102 of this number of MACHINERY.

#### Papers Presented in the Training Session

In the training session, three papers were presented, one by Louis Ruthenburg, general manager of the Yellow Sleeve Valve Engine Works, Inc., on "The Training of Shop Foremen" (abstracted on page 97 of this number of MACHINERY), one by F. T. Jones, of the White Motor Co., on "Products and By-products of Foremen's Conferences," and one by Lillian M. Gilbreth on "Training Employees in Production Work."

Mr. Jones pointed out that in establishing foremen's courses or "conferences" the greatest care must be taken that the methods used inspire confidence. Any measures proposed should be carefully planned, because often measures poorly conceived and carelessly executed produce so much dissatisfaction, discontent, and unrest as to far outweigh the valuable features of the conference. The management, therefore, cannot take too much care in considering the subjects presented before foremen's conferences, and should be sure that the organization is convinced of the value of new measures before they are put into effect.

The author then proceeded to mention a number of topics that have been successfully discussed at foremen's conferences. One important point brought out was that instead of entering the foremen all at the same time and carrying them through the course or conference together, as is the school idea, it was found better to conduct the conferences with small, selected groups of foremen. The conferences must be continued indefinitely, and there must not be any idea that a certain course can be completed and then the subject let go. In that case, there will be a reaction at the end of the training period with its inevitable let-down. This reaction must be particularly guarded against in foremen, because they are past the age at which they learn most easily, and hence, the conferences, to be effective, must be held continuously.

In her paper "Training Employees in Production Work," Mrs. Gilbreth outlined in considerable detail the methods that have been found successful in actually training workers, including the preliminary steps that must be taken, covering fatigue study, motion study, and skill study. It was emphasized that there is "one best way" in which any work can be performed, and each plant should standardize on the method that has been found most satisfactory.

#### Sheet Steel Production Session

At the session devoted to sheet steel production, two papers were read, one by G. F. Keyes, of the Mullins Body Corporation, on "Hot Stampings," and one by Syd Smith, of the Studebaker Corporation, on "Sheet Steel Fabrication." Mr. Keyes discussed the various types of methods used for producing dies, and described the procedure followed in building dies for hot stampings. The remainder of the paper was largely devoted to a consideration of the manufacturing processes for completing the hot stampings.

Mr. Smith pointed out that inasmuch as from 25 to 30 per cent of the weight of the average passenger car is produced from sheet or strip steel, and as approximately 60 per

cent of the cost of production is represented by the material used, there is a great opportunity to reduce costs by conserving material. With this object in mind, particular attention has been given to the utilization of scrap from large pieces in the manufacture of smaller parts. In the Studebaker plant, a card index file is kept, which quickly gives information as to the possibility of making any new piece from scrap material.

Great progress has been made in the last few years in the production of parts from sheet steel to replace castings and forgings. The average cost of the finished sheet-metal parts in an automobile, including the enameling, was stated to be about 13 cents per pound. This cost is about 50 per cent higher than that of iron castings, but 25 per cent lower than that of malleable castings, and 75 per cent less than the cost of aluminum castings. Forgings would cost about the same as sheet-metal parts. While sheet-metal parts do not compare favorably with iron castings on the basis of cost per pound, they make an excellent showing on the basis of strength, and much lighter parts can be used when made from sheet iron; hence, the cost of the part may not be greater, and sometimes even less, than the cost of a casting for the same purpose.

#### Inspection in the Automotive Industry

Inspection methods in the automobile industry were outlined by C. J. Ross, of the Buick Motor Co., and in the airplane industry by John J. Feeley, of the Glenn L. Martin Co. In his paper on "Inspection Methods," Mr. Ross pointed out that, with the present labor employed in the automobile field, rigid inspection is necessary. In the Buick Co. the average number of productive men per inspector varies from eleven to thirteen. A certain ratio of productive hours to inspection hours is also definitely settled, on the same basis as the working out of a budget, and in no instance is this allowance permitted to be exceeded. As an added precaution on the inspection department's work, the engineering department frequently checks the inspection department to insure that the limits called for by the drawings are being maintained.

An interesting feature brought out was that extensive application is made of spark testing, both of raw materials and of parts coming from the heat-treating department. By this method, not only can material that may have become mixed readily be sorted, but the carbon content and the composition of alloy steel can be quickly and accurately determined.

In his paper on "Inspection in the Airplane Industry," Mr. Feeley gave an explanation of the different parts of the airplane, their methods of functioning, and the movements necessary to control flight, following this by a discussion of some principles of design necessary in the development of a successful airplane. From this, the author led the discussion to the subject of inspection, indicating the careful inspection that must be provided for every step in the construction, beginning with the raw material and finishing with the final assembly inspection, which is extremely complete in its details.

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#### QUESTIONNAIRE ON TESTING LABORATORIES

The Bureau of Standards, Washington, D. C., is frequently requested to make tests of engineering materials for commercial organizations and individuals. In accordance with law, the bureau makes many tests for other government departments. Due to the large amount of official work, it is the policy of the bureau not to make tests for private individuals if other laboratories can do the work. In order to direct persons to laboratories equipped for tests, the bureau is preparing a list of physical, chemical, and metallurgical laboratories. The bureau will be glad to send a questionnaire to anyone who can give information about laboratories. Write to the Bureau of Standards, Washington, D. C., for the Questionnaire on Commercial Testing Laboratories.

## SHOP PRACTICE MEETING IN CLEVELAND

The Shop Practice Division of the American Society of Mechanical Engineers held a meeting in conjunction with the exhibit staged by the American Society for Steel Treating in Cleveland during the week beginning September 14. This session of the American Society of Mechanical Engineers was held Thursday afternoon, September 17, at the Hotel Hollenden. At this meeting, Henry K. Spencer, general manager of the Blanchard Machine Co., Cambridge, Mass., read a paper on recent developments in surface grinding machines using the cup type of wheel. Two specific lines of development were referred to—the processes for grinding large pieces, and those used for reducing cost in the surface-grinding of small parts.

In the course of presentation of this paper, Mr. Spencer called attention to the development of large grinding machines for accurately finishing large pieces. What is probably the largest vertical-spindle surface grinder ever built was mentioned as having a total weight of over 20 tons; the wheel-head alone weighs 3 1/2 tons and carries a 60- or an 80-horsepower motor directly on the spindle. This machine has a magnetic chuck 5 feet in diameter and a maximum swing for the work of 7 feet. The grinding wheel may be either 30 or 36 inches in diameter, and the base has a tank capacity for holding 500 gallons of cooling compound. On this large machine, it was stated, limits of plus or minus 0.001 inch can be readily maintained, and large pieces can be ground parallel to within 0.001 inch. Such accuracy, for example, is obtained in grinding steel plates 50 inches in diameter and 9/16 inch thick. These plates are ground on two sides in twenty minutes, floor to floor, removing 1/64 inch of steel from each surface.

The paper gave a number of additional examples of rapid grinding and also described an automatic surface grinder intended for producing small work with great accuracy.

### Automatic Die-sinking Machines

Another paper was read by S. A. Keller, vice-president of the Keller Mechanical Engineering Corporation, Brooklyn, N. Y., on "The Use of Machinery in Making Dies for Sheet-metal Work and Forgings." Mr. Keller stated that present-day manufacturing methods, based on intensive production, have developed along lines demanding the extensive use of dies for the operations connected with forging and stamping. In the past, when the output was on a comparatively small scale, neither the life of the die nor the accuracy or uniformity of the die product was so much of a factor. Dies of cast iron and bronze, with little hand work and machining answered the purpose in many cases, where today all steel, or cast iron with steel inserts, are found necessary. Even where cast iron is still used, dies and punches must fit well and must be correct to the predetermined design.

The scribe-line methods, relying on the use of eye and hand, and the fitting to sheet-metal templates by the cut-and-try methods, are clearly too uneconomical and slow when dies have to be made in the quantities and in the time demanded by the automobile industry in its sheet-metal production. Similar considerations apply to forgings. More is demanded of the die product in the way of closer tolerances. This, together with the larger quantity to be made, means more frequent die duplication and replacement. Uniformity and interchangeability of dies are of great importance, and die costs must be kept down. Automatic machine methods have had to take the place of the hand miller and chipping method which seemed adequate when comparatively few dies were made.

As always, the need of the industries has here too been met by mechanical development. Die-cutting machines operating on the principle of a cutter guided by and working in unison with a tracer following a model, have been used for many years. The earliest application of automatic die-cutting was to ornamental work, such as medals, jewelry, and silverware. The machine that came into industrial use for this class of work about thirty years ago was a reducing

machine, requiring the use of a model much larger than the die to be cut.

The demand for an automatic duplicating die-sinking machine was next met. The development of this type of machine eventually proved to be of great importance to the die-using industries, and today these machines are installed in practically every important automotive forge shop. The list of the varied industries using this type of machine run from glass bottles to silverware.

The fact that a master of hardened steel or hard bronze was required on these machines was a handicap. This was overcome some years ago by the electric tracer control, by means of which the tracer pressure is reduced to a few ounces, regardless of the work performed by the cutter. The use of masters made of cement, plaster, lead, or wood was thereby made practicable. Thus the usefulness of the duplicating die-cutting machine was greatly enlarged. These machines are made in several sizes, the largest having a die capacity of about 20 by 25 inches. Not only are three-dimensional dies cut by either full automatic or semi-automatic methods, but two-dimensional dies such as blanking and trimming dies, come within the scope of these machines.

W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, presented a paper entitled "The Steel Missionary," in which he pointed out the importance of the civilizing influences of engineering activities in countries not as highly developed as the United States. An abstract of this paper will be presented in a coming number of MACHINERY.

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## MACHINE TOOL BUILDERS' MEETING

The twenty-fourth annual convention of the National Machine Tool Builders' Association, held in Washington, D. C., September 30, October 1, and 2, included in its program the regular business meeting, at which the president, O. B. Iles, of the International Machine Tool Co., Indianapolis, Ind., made his annual address. At the same meeting the general manager's report and the treasurer's report were presented. One of the important events of the convention was the report of the committee on code of ethics and a discussion of the practices destructive to the principles of business conduct, which principles were accepted at the annual convention in October, 1924.

One of the sessions was held at the Department of Commerce Building, this session having been arranged for by the Industrial Machinery Division of the Department of Commerce. Brief addresses were made regarding the work of the department on behalf of the machine tool industry. An address was also presented by Major R. H. Somer of the Ordnance Department of the United States Army on "Machine Tools and the Munitions Program." At another session held at the United States Bureau of Standards, an address was made by Dr. George K. Burgess, director of the Bureau of Standards, this address being followed by an inspection of the laboratories and equipment.

The last day of the convention was devoted to a joint meeting with the Army Ordnance Association at the Aberdeen Proving Grounds, Aberdeen, Md. At this meeting there was a demonstration of coast artillery and anti-aircraft guns, and also of field, military and commercial aircraft, of mobile artillery, of artillery repair shop equipment, and of ordnance automotive equipment.

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According to the Department of Commerce, the United States is now the world's greatest investor. The dollar is widely used as a basis for international transactions even where the United States is not directly concerned. Twelve years ago, the New York foreign exchange market was insignificant, and the nation was heavily indebted to Europe. Our total foreign holdings, excluding debts owed to our government, amount to about \$9,000,000,000, having increased by about \$1,000,000,000 during the past year.

# Rockwell Dilatometer

Apparatus for Determining Correct Hardening Temperatures of Steel by Indicating and Recording Dimensional Changes during Decalescence Period

By STANLEY P. ROCKWELL, Consulting Metallurgist, A. G. M. A., and President, The Stanley P. Rockwell Co., Hartford, Conn.

**H**EAT-TREATMENT changes the physical properties of steel. The physical properties that are commercially considered are hardness, tensile strength, elastic limit, elongation, etc. These physical properties are affected by internal physical changes. When heat is applied to a piece of steel, it expands, as is generally known. This expansion is due to changing of the internal physical constituents, and is commonly known as linear or volumetric expansion. It will be seen that by measuring the steel during its heating, the dimensional changes will serve as a guide as to what is taking place within the steel.

A critical transformation in steel is evidence of a change in internal physical characteristics. The most important one is that which occurs just before a piece of steel is ready for quenching to obtain full hardness. This is called decalescence, and its presence has been noted by loss of magnetism and by measuring a cessation in the heating rate by pyrometry. Decalescence may be noted more accurately by measuring the volumetric changes. When volumetric changes in steel subjected to heat are noted by mechanical means of measurement, the method is known as the dilatometric method. For the exact measurement and study of volumetric and critical transformation, leading physicists use this method in preference to the pyrometric method, where temperature changes are noted. The reasons are that dilatation measures the changes through the mass of the metal, while temperature measures only that metal adjacent to the thermo-couple junction.

## How the Dilatometer Indicates Critical Transformation

The dilatometer, which is shown in Fig. 1 applied to a furnace, is a sensitive, rugged apparatus, designed to indicate on a dial *H* (see diagram, Fig. 2) and to record graphically at *I* the dimensional changes in metals undergoing heat transference. The dimensional changes are extremely small, and the dilatometer is designed to magnify them to such a degree as to be clearly seen. One revolution of the pointer equals a change in length of 0.2 millimeter (0.0079 inch).

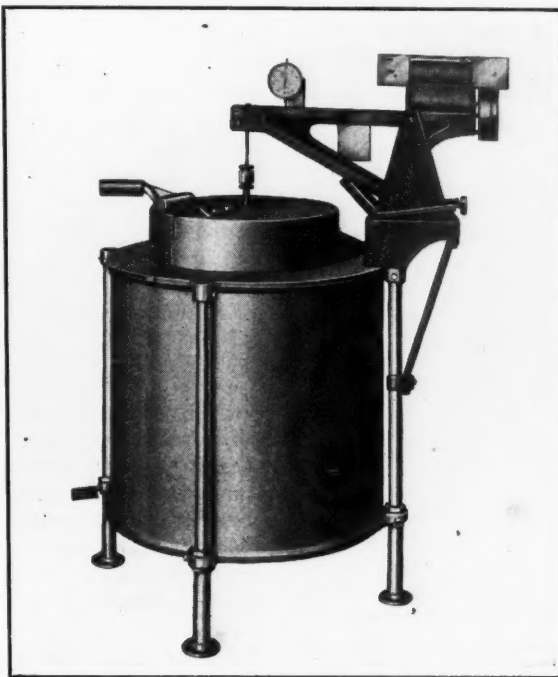


Fig. 1. Rockwell Dilatometer which shows Dimensional Changes in Steel during Heat-treatment

The work (such as a single gear, gears stacked on top of each other, or dies, tools, etc.) is placed in the furnace, and the dilatometer brought into contact. Immediately, the pointer on the indicating dial at *H* starts to revolve and continues to revolve (thus indicating expansion) in the same direction as long as the furnace temperature is hotter than the work and until the point of initial critical transformation occurs. At this time the pointer stops and revolves in the opposite direction, indicating contraction. At the completion of this critical transformation, the pointer stops and revolves in the same direction as at first, indicating resumption of expansion. At this point the work has completed its critical transformation, and all stresses and strains

are equalized. The grain structure resulting after quenching at this time will be refined to the maximum, and maximum hardness will result with the type of quenching media used.

The dilatometer (which is licensed under patent No. 1492804 and patents pending) gives an exact indication of the dimensional changes occurring in heating. These changes are far more accurate and important than the less pronounced and less sensitive temperature changes, for securing the maximum wear, hardness, tensile strength, and other physical properties desired in the finished tool. With the proper furnace equipment the dilatometer gives, in addition, absolute control of the rate of heating—a factor of great importance in tools of intricate design and variable cross-section.

Dilatation, being mechanical, is not subjected to lag in the indication or recording of results, while temperature measurement depends on the rate of heat transmission through the steel under treatment, the air gap between the steel and the thermo-couple, and the thermo-couple junction itself. The diagram Fig. 2 will suffice to show why a lag exists in temperature measurements and not by dilatometric means. A furnace is represented at *A*; *B* is a fire-clay rack for a gear, die, or tool; *C* is a thermo-couple; *D*, a steel die; *E*, a pyrometer; *F*, a fulcrum of

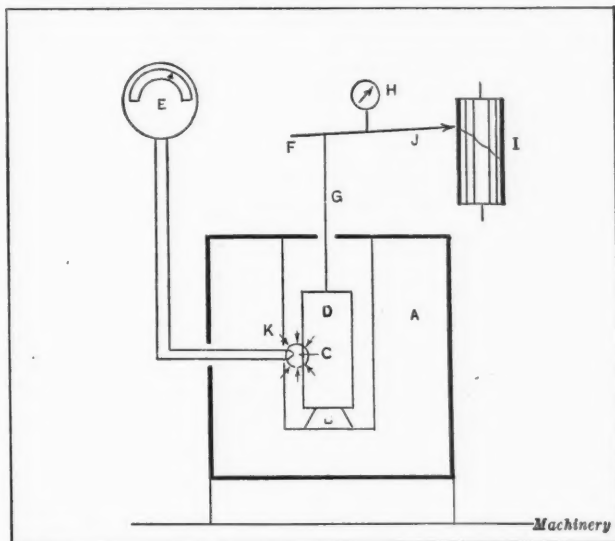


Fig. 2. Diagram of Furnace with Dilatometer and Pyrometer Equipment

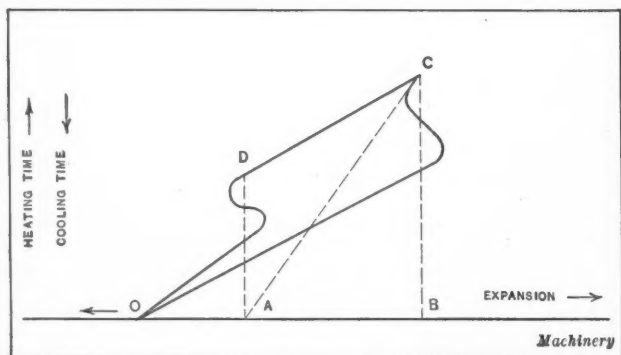


Fig. 3. Dilatometric Graph showing Volumetric Changes in Steel during Heating and Cooling

lever *J*; *G*, a quartz tube; *H*, a Rockwell indicating dial; *I*, a Rockwell recorder; *J*, a common lever to magnify motion; and *K*, a circle with arrows to indicate heat flow to the thermo-couple junction *C*.

With the exception of the Rockwell dilatometer, the relation of the die, furnace, and thermo-couple is as arranged in other heat-treating practice where temperature measurements or critical temperature observations are made. The point *C*, which is the thermo-couple junction, is the only point in the whole system whose temperature is measured. A change in temperature at *C* can only be effected by heat changes external to it. These external changes are radial. The circle with arrows represents the various heat intensities tending to affect the point *C*. A greater percentage of heat intensity area emanates from the furnace and walls than from the steel die itself. For this reason, a lag results in indicating the actual temperature of the steel.

On the other hand, the dilatometric principle utilizes the steel under heat-treatment as its own indicator of thermal changes. It has been found necessary, and is customary in securing charts of critical temperatures, to allow a certain excess temperature after the break in the time temperature curve has been passed. This excess temperature has been found to vary with the steel used and its size and contour. This is the only way in which correction for lag can be made, and the temperature method, instead of being exact, is conducive to errors.

In order to demonstrate more clearly the difference between the temperature and the dilatation methods, a bar of tool steel, 5 inches long and 1 inch in diameter, was heated, and dilatometer equipment employed. During the period of

heating, which was 1 hour and 35 minutes, temperature measurements were noted by a very delicate thermo-couple and milli-voltmeter. The thermo-couple junction was in contact with the outside of the bar at a point half way between the ends. Fig. 4 is the dilatometric chart.

If one considered temperature merely as an indication of decalescence, 1380 degrees F. would be the figure. Actually contraction, which indicates true decalescence, begins at an indicated temperature of 1365 degrees F. This meaning that the heat emanation of the steel under treatment is too feeble to affect the thermo-couple, which is the lag mentioned. During the 1380-degree period, the heat emanation is of sufficient intensity to maintain constant temperature at the thermo-couple junction. After the 1380-degree period, the thermo-couple temperature increases, but contraction is still strong. Again temperature error is apparent. At the thermo-couple temperature of 1440 degrees F., re-expansion takes place, and full hardness is secured on quenching. The period on the curve of 1380 to 1440 degrees, noted by temperature measurement, represents the customary temperature increase allowance found necessary when hardening by the temperature measurement devices.

#### Control of Grain Size

At the exact completion of the critical transformation, the grain size of the steel is smallest. Instantaneous quenching at this time would retain this minimum grain size and maximum hardness for that particular grade of steel. Instantaneous quenching to room temperature is, however, impossible. If quenching is conducted at the end of the critical transformation as shown by the re-expansion on the dilatometer, a depth of hardness will be found to exist in direct relation to whether brine, water, or oil is the cooling medium, and in relation to the alloying elements in the steel. Brine will give a greater hardening depth than oil. To secure as great a hardening depth with oil as with brine, it is customary to heat the steel to a greater degree above the critical transformation. This, of course, causes an increase of grain size, which may or may not be detrimental, depending on the use of the hardened part.

Certain tools, such as blanking dies, milling cutters, and taps, which are mostly subjected to shearing stresses, require as fine a grain as possible commensurate with hardness. Other tools, such as cold heading and stamping dies, require for their maximum life a depth of hardness which is customarily obtained by heating in excess of the critical transformation, at the expense of grain size. Success in obtaining these results depends on a reliable method of maintaining a proper rate of expansion and heating before reaching the critical transformation, a definite and exact knowledge of when that transformation is reached, its duration, and just how far above to allow re-expansion to continue before quenching, this being vital in regard to grain, warping, and cracking.

#### Causes of Failure in Hardening

The saying that the lowest heat at which steel can be hardened is the best heat expresses a common-sense idea. Kinds of steel, quenching media, and uses for steel, however, affect this. It is realized that excessive heats increase grain size, but it has been found difficult, by pyrometry, to get a graphic and clear idea of the relation between temperature and grain size in various steels. The dilatation principle gives this, on account of its very simplicity and its direct relationship to grain structure. Other factors, such as heating rate, furnace atmosphere, etc., affect production costs and length of tool service.

As previously explained, steel subjected to heat expands, then contracts during the critical transformation period, and, finally, re-expands. The faster the heating rate, the faster these changes. It has been customary, in measuring the critical transformation by pyrometry, to heat slowly so as to have better control of these characteristics, which have

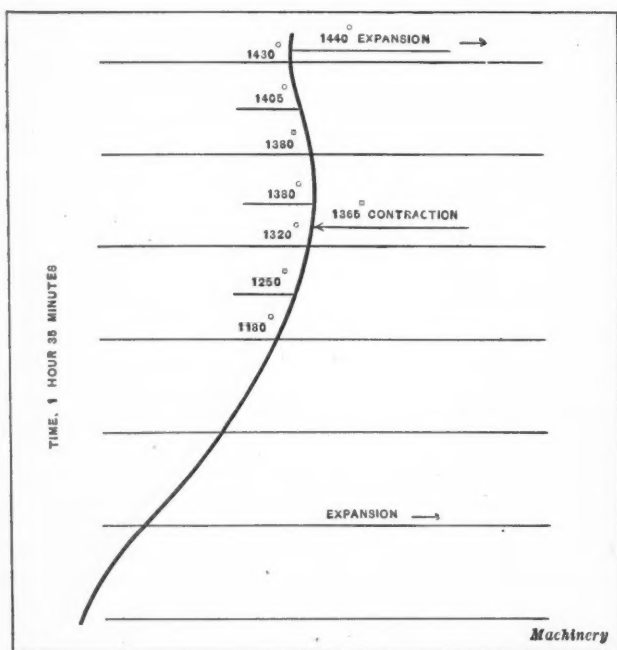


Fig. 4. Dilatometric Chart which shows how Decalescence Period is indicated by Contraction and Expansion Curve

been considered to be present but which have not been shown visually. As the dilatation method shows these visually, extremely slow heating, when not necessary, can be avoided, and accurate and duplicate results obtained. It is therefore of importance that the furnace equipment be of good construction as regards heat uniformity, control, and heating rates.

#### Cracking and Soft Surfaces

Cracking of tools is due to unequal expansion rates in light and heavy sections. For such tools, a slow heating rate is desirable, and with the dilatometer to show the expansion rates, proper control is obtained. Volumetric change in steel is unquestionably one of the most important factors in hardening, as regards warping and cracking. Often parts requiring the depth of hardening expected with brine quenching, can only be quenched in oil, as otherwise failure results, due to the speed and intensities of the volumetric changes on cooling.

Fig. 3 is a dilatometric graph representing heating and cooling. Line *OC* represents volumetric changes during heating, and *CDO* represents volumetric changes during cooling. As steel is austenitic from *C* to *D*, quenching from any point on line *CD* will secure hardening. If quenched in brine at *C*, then *OB* would represent a function of the volumetric change encountered, which would effect warping and cracking. If quenched in brine from *D*, the volumetric function *OA* encountered would be less than the *OB* function. If a slower coolant such as oil is used, and quenching is done from *C*, then *OA* is the function to be considered. It then appears that quenching from *D* in brine would secure results commensurate with oil cooling from *C*, as regards warping and cracking, but would give additional hardening depth.

Soft surfaces and soft spots on tools are primarily due to the removal of surface carbon by the formation of scale. Surface scale is due to furnace atmosphere. Hardeners are in favor of different methods of heating furnaces, primarily in order to secure a desired furnace atmosphere, electricity and gas being their foremost preferences for tool work. The source of heat is immaterial when using the dilatometer, so long as the heat is uniform throughout, the heating chamber control is positive, and a desirable atmosphere is secured.

#### Equipment for Dilatation Method

The dilatation method requires for its operation a furnace for heating, a Rockwell indicating dilatometer, a recorder, if permanent records are to be kept, and a quenching tank nearby with the desired quenching medium. An indicating or recording pyrometer may also be used, if desired, thus giving additional information. Any furnace capable of close temperature control is satisfactory for use with this method. Either electric or gas furnaces are preferable. The recorder draws the resultant line of time and dimensional changes.

The sample chart, Fig. 5, illustrates the nature of the curve during the operation of heating for hardening. Point *A* indicates the dimensional size at the time the work was placed in the heated furnace, the heat supply having been shut off and the dilatometer brought into contact. The work expands at a decreasing rate to the point *B*, corresponding to the amount of residual heat in the furnace. In other words, at point *B* a temperature equilibrium between work and furnace exists, and all parts of the work are equally expanded. At *B* the fuel supply to the furnace is again applied, so as to bring the temperature of the work and the furnace up at the same rate. Expansion of the work is again resumed, decreasing slightly before the point *C*, at which point there is a reversal in the direction of the curve. This reversal marks a contraction in the work, and is an exact indication that the steel is entering the critical transformation range. This contraction continues until the transformation is completed at *D* on the curve. At the completion point *D*, re-expansion takes place and is allowed to continue to *E*, at which time the work is removed from the furnace.

As has been explained, the point at which the critical

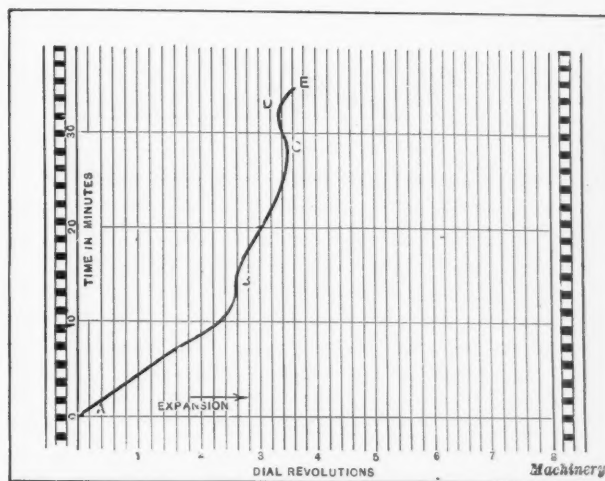


Fig. 5. Curve from Dilatometer representing Hardening Heat for Carbon Steel Milling Cutter

transformation occurs, which is shown very clearly by the reversal in the curve, is the basis for all hardening. This reversal signals the beginning and the end of the critical transformation, and is independent of all unknown factors. The temperature of *C* and *D* may be found readily, if desired, by inserting a thermo-couple in the furnace and placing the junction adjacent to the work being treated.

As a convenience to the operator, an alarm attachment is provided with the dilatometer so that a certain tone bell or colored light operates during expansion, and bells of other tones, or colored lights, operate during contraction.

#### Production Hardening

The Rockwell dilatometer is particularly adaptable for production hardening. Fig. 6 shows a series of curves representing gear blanks which have been preheated in a separate furnace, the final heating being in conjunction with the dilatometer. For this class of work, the upper part of the curve is the main consideration. These curves represent single gears. Stacked gears or other parts may be treated by the same method. With the positiveness of this principle and the power which is evolved in the volumetric changes, electrical contacts indicating the changes are readily operated. These, in turn, may be made to operate electric motors for conveying, etc. An equipment operating under the patents is now designed to transport transmission gear shafts from a preheating furnace, to the final heating furnace, thence to a quenching bath and to a tempering bath.

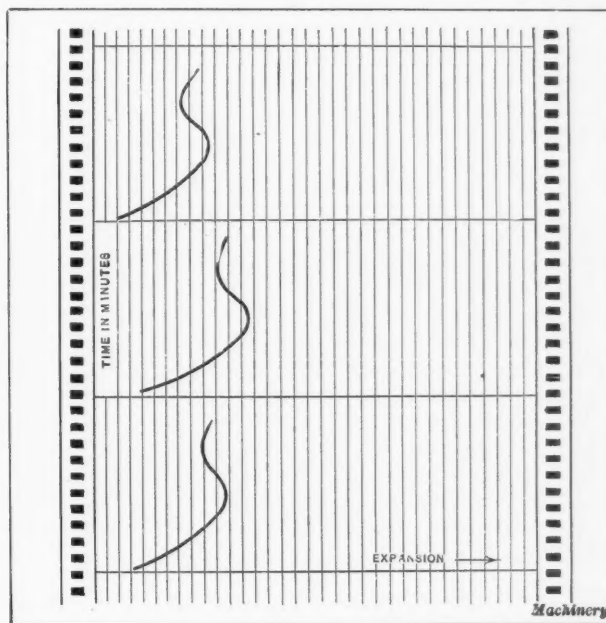


Fig. 6. Series of Curves representing Final Heating of Gear Blanks

# The Machine-building Industries

GENERAL business conditions are satisfactory, production in most of the basic industries has steadily improved since June, prices show a tendency toward advancing, and the distribution of manufactured goods, already having reached a large volume, continues to increase. Railroad freight shipments are unusually heavy, and employment in most industries has reached the point where it is difficult in many centers to obtain a satisfactory class of labor.

The Federal Reserve Bank of Cleveland points out that business in several lines is experiencing a greater activity than is usual at this time of the year. An analysis has been made by this bank of the net earnings of forty-two large and representative industrial corporations in the United States having total resources of over seven billion dollars. The result of this analysis shows that the net profits, after all deductions have been made, except dividends, of the forty-two corporations for the first half of 1925 was 21.7 per cent greater than for the first six months of 1924. These statistics bring out forcefully the improvements that have taken place this year as compared with last. Even some of the most conservative business statisticians admit that "good business is now a self-evident fact."

The only cloud on the business horizon is the anthracite coal strike, but the chief effect of this strike so far has been the stimulation of bituminous coal mining, and, although coal and coke have advanced somewhat in price, iron and steel production has not been affected by any coal shortage and is showing a consistent increase. Another satisfactory indication is that August failures in business showed the smallest amount of liabilities since May, 1920. It is generally pointed out that the extraordinary development of the southern industries and railroads is among the chief factors in the industrial activity, and that the buying of the South is an important factor in the production of the basic industries.

Compared with the average for 1919, which was considered by most manufacturers as an unusually satisfactory year, pig iron production in August was 6 per cent higher and steel ingot production 22 per cent higher than six years ago. The manufacturing industries in general are producing about 30 per cent more goods than in 1919, the textile and leather industries being the only ones among the major industries that are showing a decrease in production compared with the year mentioned. The automobile industry naturally leads, by a production of 146 per cent in excess of the average for 1919.

## The Machine Tool Industry

There is a steady demand for machine tools for replacement purposes from practically all industries, with the automobile industry leading in the volume of new equipment purchased. Several manufacturers state that the machine tool business has not been in so satisfactory a state as it is at the present time, since early in 1920. In commenting upon this situation, Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, makes the following statement:

"All statistical curves based on production figures show that production has been increasing. The automobile industry and the building industry have been above normal, and put together have made for a relatively high rate of iron and steel production. The electrical industry has likewise continued to increase, but this increase is not so far above the normal trend of the last few years for that industry as is the case with automobiles and buildings.

"Much of the machine tool demand has come in recent months from the automobile industry. There has been some good, steady, healthful replacement demand in other industries, but it does not seem to equal the demand that for various reasons has come from certain elements of the automobile business."

Mr. DuBrul further points out that the present price reductions in the automobile field, accompanied by improvements in the cars themselves, mean that the automobile builder must look for further methods for reducing production costs, and, therefore, is likely to be in the market for some time to come for more modern machine tools to replace older, less efficient types. On the other hand, it should be pointed out that the situation in the automobile industry is not sufficiently stable to justify the machine tool builder counting too strongly upon the continuation of the present demand, and Mr. DuBrul advises that contracts should be worded in firm language with every legal safeguard thrown around them to prevent cancellations.

## The Iron and Steel Industry

The production in the iron and steel field has gradually increased, and prices show a tendency to increase simultaneously. It is evident now that July marked the low point in the present production cycle in this industry. The August steel production was about 11 per cent greater than that of July. Pig iron production increased also in August for the first time since last March. The furnaces in blast in August were 192 out of a total of 391, or 49.2 per cent, against 47.5 per cent in May. The United States Steel Corporation is operating at more than 75 per cent of capacity, with the independent companies operating at about 70 per cent. New construction work demanding structural steel is planned on a very large scale, and the demands for steel from the automobile industry continue to be exceptionally great for this time of the year.

Just what effect the coal strike will have on the iron and steel industry is difficult to predict. The anthracite strike involves 150,000 men employed by 135 companies at 828 mines. It is estimated that 266,000 tons of coal remain unmined daily, with a loss of \$1,150,000 in wages per day. Ten thousand railway employees have also lost their jobs due to the stoppage of the coal traffic.

## The Automobile Industry

The reports from the automobile industry are most surprising. The production cycle this year is quite different from that of past experience. The decline in production in August was less than the usual seasonal drop, and the total number of cars built was nearly as large as in July. Furthermore, September schedules are such that the production during the past month will not be far below August. There have been a number of decided price reductions, but the fact that the Ford Motor Co. did not reduce its prices on the new models is considered as a stabilizing factor in the industry at this period of intense competition. Ever since last March, production of passenger cars has exceeded the 300,000 mark, reaching its high level in April with over 375,000 cars. Meanwhile, truck production has been over 35,000 trucks a month, reaching its peak in April with 46,250 trucks.

It is encouraging to note that the agricultural implement industry, which has suffered as severe a depression as any other field, reports steadily increasing sales. It is estimated that this industry is now operating at from 75 to 80 per cent of capacity.

# New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

## NORTON SEMI-AUTOMATIC GRINDING MACHINE

With a view to obtaining higher production rates in cylindrical grinding, the Norton Co., Worcester, Mass., has just brought out a 12- by 18-inch type B semi-automatic machine. Starting and stopping of the work, the flow of grinding compound on the wheel, and the continuous power in-feed with the rapid reverse at the end of the cut, are all accomplished automatically by means of a cam and pneumatic valves and

pistons. A single lever starts the cycle of operations. The automatic features are incorporated with the idea of reducing the number of motions required on the part of the operator to a minimum, so that two machines can be operated simultaneously by one man.

The machine is substantially a type BA special-purpose machine, with automatic controls added and the base and work-carrying parts made heavier to give greater rigidity and permit higher production. It is entirely self-contained, power for the grinding wheel and wheel feed being supplied by a constant-speed motor bolted to the rear of the base, while the work is revolved on dead centers by a headstock driven by an adjustable-speed motor. One of several points in favor of the main motor drive used is that there is a choice of several makes of standard motors.

Models of this machine now completed have a 12-inch maximum swing over the swivel table, and take work up to 18 inches long between centers, although it is contemplated to add longer machines later. Wheels 20 inches in diameter, up to 9 inches thick, can be employed, which makes the machine capable of taking cuts up to 9 inches long. The Norton wheel-spindle

reciprocating attachment gives the grinding wheel an oscillating motion of 1/4 inch, which is claimed to reduce wheel wear, produce a better finish, and permit higher production rates.

The micrometric wheel feed is positively controlled by a cam which allows the wheel-slide to move toward the work to a positive stop, and then automatically reverses to move the wheel back from the work. After the automatic cycle has been started, the operator is free to prepare work for the machine or to look after another machine. The cycle consists of starting the work revolution, turning on the flow of the grinding compound, feeding the wheel toward the work to a positive stop, rapidly reversing the feed to back the wheel from the work, stopping the rotation of the work, and shutting off the flow of compound. The rate of in-feed, which determines the time required for the cycle, can be varied by means of change-gears to suit the different materials ground. The revolution of the work is started and stopped automatically by the action of a

cone clutch and brake which avoids the necessity of starting and stopping the motor.

To remove the work from the centers, the operator merely steps on a foot-pedal which operates a valve controlling an air piston in the footstock. This valve actuates the footstock spindle, pulling the center from the work, or the reverse as desired. The arrangement allows the operator the use of both hands for removing the finished piece from the machine and for placing the next piece in position on the cradle.

The wheel-slide is the regular type B design with the improved spindle bearing construction which permits adjustment while the spindle is running. A reservoir in the

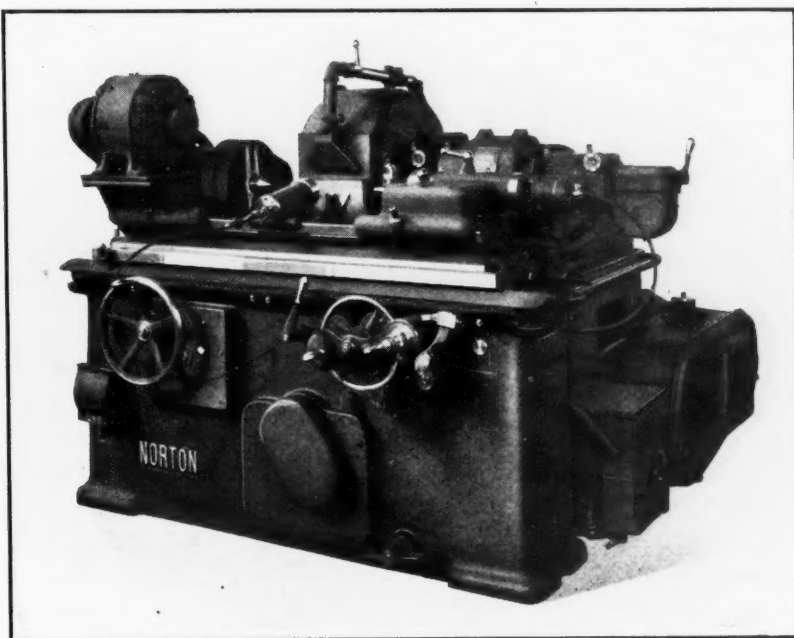


Fig. 1. Norton Semi-automatic Cylindrical Grinding Machine

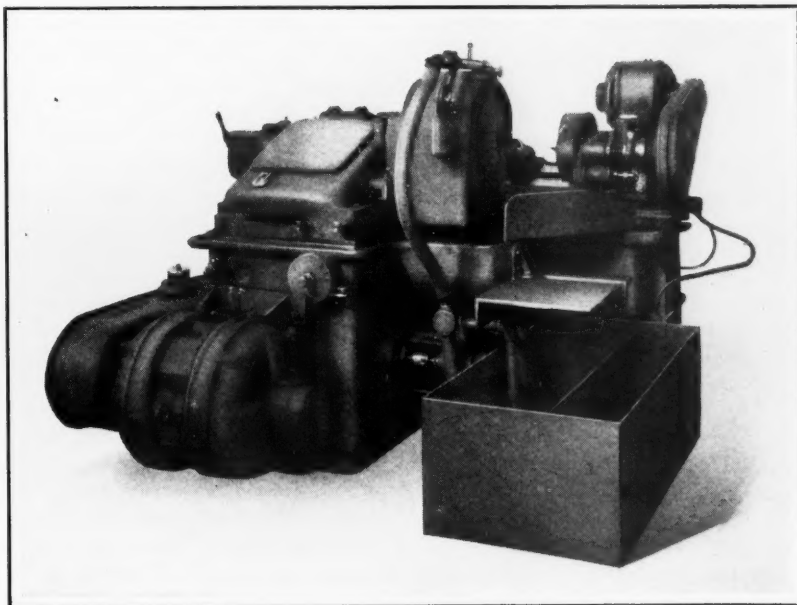


Fig. 2. Rear View of the Semi-automatic Cylindrical Grinding Machine

wheel-slide supplies lubricating oil by means of a chain-driven pump to the spindle journal and thrust bearings. The stream of oil flowing on the bearings is visible to the operator through glasses on the front of the slide. The base rests on three points. The work-tables are made low for the convenience of the operator in handling heavy work. Both the headstock and footstock are pneumatically controlled. Grinding compound is supplied to the wheel by a pump mounted on the main driving shaft, which draws the compound from a large pump tank and settling tank at the rear of the machine. This machine is intended for grinding such work as medium sizes of outer rings for ball and roller bearings, short shafts to be ground with wide cuts, bushings, and other miscellaneous work.

### GRAY OPEN-SIDE PLANER

After having been engaged in the manufacture of double-housing planers for about forty-five years, the G. A. Gray Co., Gest and Depot Sts., Cincinnati, Ohio, has announced an open-side planer which will be built in 36-, 42-, 48-, and 60-inch sizes. The 36-inch planer was exhibited at the National Steel and Machine Tool Exposition held at Cleveland from September 14 to 18. The column and knee, which support the cross-rail, are made heavy and of unusually rigid proportions, which is evident from the fact that the 36-inch planer has taken cuts in forged steel at a feed of  $3/16$  inch and a depth of 1 inch.

The column is triangular in section, it being claimed that the walls of such a column are directly in line with the forces to be resisted, with the result that there can be no yielding at the corners. A wide column face provides adequate support for the side-head even

when long-reach tools are used. Heavy internal braces are cast integral with the column to add to its rigidity.

The bed is cast solid across the bottom under the gears. A heavy brace runs across the top directly under the cutting tools and the rail, for the purpose of eliminating vibration at this important point in the machine. The remainder of the bed is cast solid on top. For ease in leveling, and to relieve internal strains in the casting, the bed is planed on the bottom. A heavy outer wall of the bed extends to the level of the table top to support the column as high up and as near the rail as possible. The column and bed are fastened together by a heavy tongue and groove. All parts of the bed and driving mechanism are above the floor line.

The gear train is similar to that used for years in the double-housing "Maximum-Service" planer. The gears and table rack are cut from steel forgings and have helical teeth. A novel feature is the design of the bull gear, which offsets the pressure of the tools on the work by exerting a side thrust on the table. As the tools are usually fed away from the operator, the bull gear tends to push the table in the opposite direction, thus materially decreasing the tendency of the table to lift under a heavy cut. To still further re-

duce this tendency, the bull gear teeth are designed with a 9-degree pressure angle, so that the force exerted is very nearly in a horizontal direction. The gear train runs in a bath of filtered oil, and the bronze side-thrust bearings provided on each shaft run in a flood of oil. Automatically oiled side thrust bearings are also provided between the table and the bed.

To prevent the table from tilting in any position when planing overhanging castings of awkward proportions, hold-down gibs are provided over the entire length of the bed and table. The oil pumped to each vee flows over the hold-down gibs so that they run in a flood of oil. As the upward pressure on a gear may at times be almost as great as the downward pressure normally exerted on the vees, this oiling is a precaution of much value. If it is necessary to remove the table, the gibs can be disengaged without running the table off the bull gear.

A novel lock which can be applied or released from the usual operating position by the use of a single crank locks the knee to the inside of the column in four places. The clamping effect is automatically balanced, so that the operator cannot possibly lock one clamp without locking the others. The clamping pressure obtained is said to prevent

any vibration or shifting between the knee and the column even in taking heavy cuts. It is applied at the front, the rear, and the upper and lower edges of the knee. Adjustment for wear is entirely automatic, so that the knee lock requires no attention.

The operator can set the rail in any desired position by the use of the "rail setter" lever at the operating position. A partial turn of the wrist suffices to unlock this lever, and the direction of the rail travel corresponds to the direction in which the lever is moved. It is mentioned that the

absence of "drift," when the lever is pushed into the off position, facilitates setting the rail to a line which eliminates the tendency to take a long reach with the cutting tool and enables heavier cuts to be taken.

An entirely new device is a ball-bearing spring counter-balance, which offsets the overhung weight of the knee and relieves the rail-elevating screw of bending strains, thus making it easier to raise and lower the knee and rail. This device consists of a ball-bearing roller mounted at the right-hand end of the rail on top, against which heavy springs function to force the roller against the right-hand edge of the column face. This keeps the rail and knee snug against the column even when unclamped.

To set a head into position, one motion is given to the rapid traverse lever to start the motor in the right direction, disconnect the manual crank to avoid accident, and disconnect the feed mechanism. Putting the lever back into the "off" position automatically reconnects the power feed to the head and reconnects the crank. The advantage mentioned for this control is that the operator can quickly jump over a gap in his job without wasting several strokes with the power feed. One rail-head can be moved into place while

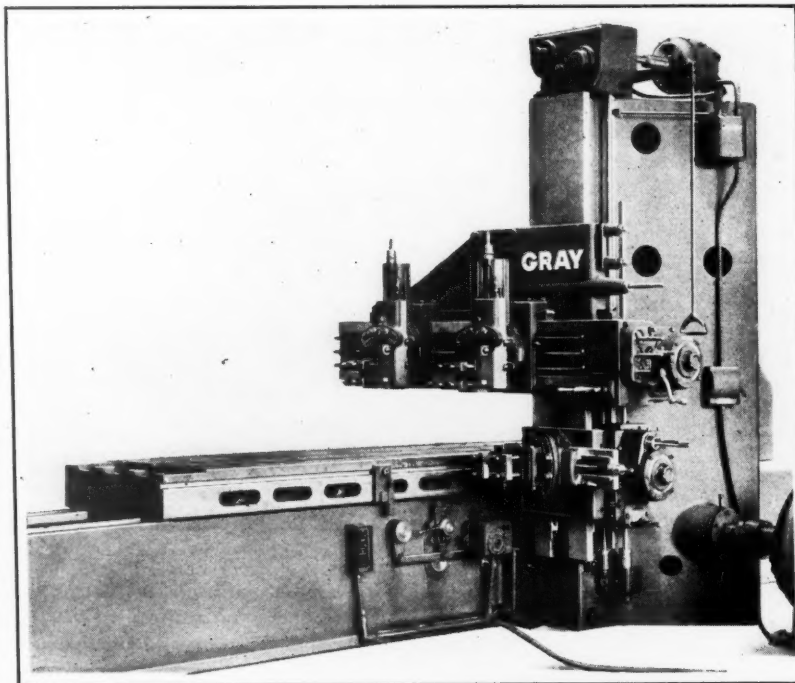


Fig. 1. Open-side Planer placed on the Market by the G. A. Gray Co.

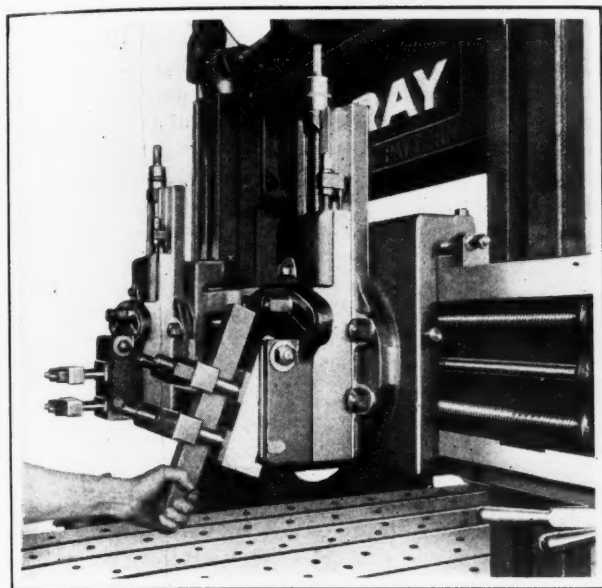


Fig. 2. View of Planer Head, showing Abutment and "Twin-purpose" Taper Gibs

the other is cutting, without interference, and the slides can similarly be moved up and down by the rapid traverse. In case one head strikes another, or the slide moves down too far so that the tool strikes the table or the work, the safety clutch disengages to stop the traverse motor.

This planer is also equipped with the "Cantslip" feed, which is positive and insures the exact feed for which the operator sets the dial. It is self-locking and is graduated in thousandths of an inch. A partial turn of the wrist automatically unlocks the dial and permits it to turn to any desired feed within 0 and 1 inch, in steps of 0.01 inch. When the side-head is furnished, it has a rapid traverse lever entirely independent of those provided on the rail, and it also has its own "Cantslip" feed dial.

The tool aprons are provided with an abutment or shoulder across the lower end which prevents springing of the apron under the strain of clamping the tool. The shoulder bears against a corresponding surface on the lower end of the tool-box, so that the upward thrust of the cutting tools comes on this shoulder and not on the taper pin. In addition to the oiling provisions already mentioned, centralized oilers are furnished on the rail, rail heads, side-head, and column. The machine can be arranged with a self-contained countershaft drive, motor drive with the motor mounted directly on the column, and reversing motor drive. Many of the features mentioned are covered by letters patent and by patent applications.

## SOCIÉTÉ GENEVOISE THREAD GRINDING MACHINE

The principal difficulty in the production of accurate parts which are threaded and hardened is to overcome the distortion that takes place during the hardening process. The hardening is almost invariably accompanied by a change in the lead of the threads and irregular changes in the diameters. To correct these errors, a machine has been developed by the Société Genevoise D'Instruments de Physique, Geneva, Switzerland, which finishes screw threads by grinding. This machine is being marketed in this country by the R. Y. Ferner Co., Investment Bldg., Washington, D. C.

The machine is equipped with a lead-screw that is guaranteed to be true within 0.0001 inch for a length of 12 inches. Shorter lengths have a still higher degree of accuracy. A correcting guide or templet at the front of the machine is cut in accordance with the measured errors of the lead-screw, and through its connection to the nut of the screw, automatically compensates for the small errors existing in the screw. This guide or templet can be adjusted about a

pivot at its right-hand end to provide for grinding screws at any temperature between 32 and 68 degrees F.

The grinding wheel is mounted on a spindle that can be tilted sufficiently to bring the plane of the wheel parallel to the helix angle of the thread to be ground. On the support of the wheel there are two micrometer adjustments, one to control the depth of the cut, and the other, the lateral movements of the wheel in the screw thread. An eccentric lever provides for the quick withdrawal of the wheel at the end of the cut before returning it to the starting point. This is accomplished without altering the adjustment of the micrometer screw. The drums of the micrometer screws are graduated to read to 0.0002 inch when the machine is graduated on the inch system.

The shape of the thread is obtained from the profile of the grinding wheel, which is formed by the use of a diamond mounted on a carriage that may be revolved about a vertical axis. The carriage movements may be measured by means of a graduated circle which reads to minutes. This design permits of regulating the profile angle of the wheel. By fixing the carriage in its middle position and turning it about its vertical axis, it is possible to give the edge of the wheel the rounded profile required for the flanks of Whitworth threads.

A vertical microscope fitted over the edge of the wheel provides for checking the profile as it is being made and for measuring the angle, depth, and lead of the threads during the grinding process. The eye-piece of the microscope is fitted with two cross-wires at an angle of 60 degrees, or at an angle of 55 degrees for use with Whitworth threads. There are also movable wires controlled by means of a micrometer. Illumination from below is furnished by the use of a right-angle prism and an electric lamp mounted in the base of the microscope support. The microscope cannot, of course, be used for examining internal threads, but the simple positioning of the emery wheel makes it possible to examine the profile of the wheel frequently, to insure that the correct form of thread will be produced.

The work is mounted between dead centers, a work-carrier being driven by an index-finger mounted on a dividing plate which is, in turn, carried by the faceplate. This dividing plate is graduated, and can be moved relative to the faceplate to enable the grinding of all the threads of screws having more than one thread.

External threads up to 6 inches in diameter may be ground, as well as internal threads between 1 1/4 and 5

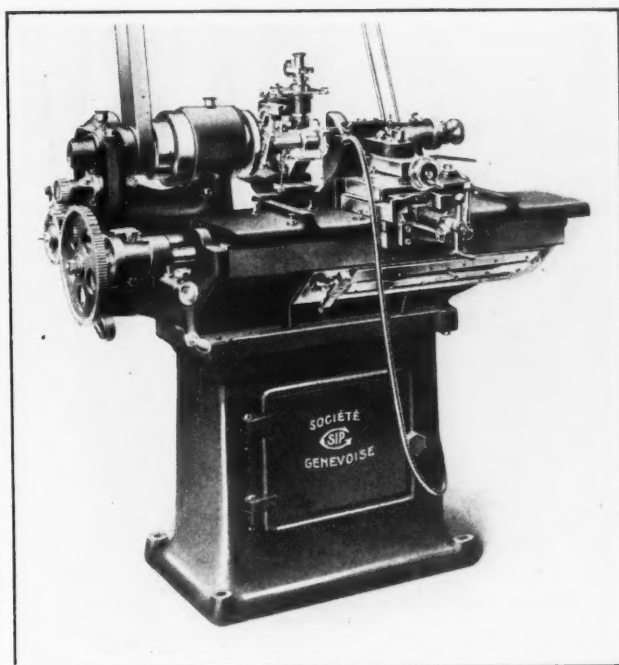


Fig. 1. Societe Genevoise Machine for grinding External and Internal Screw Threads

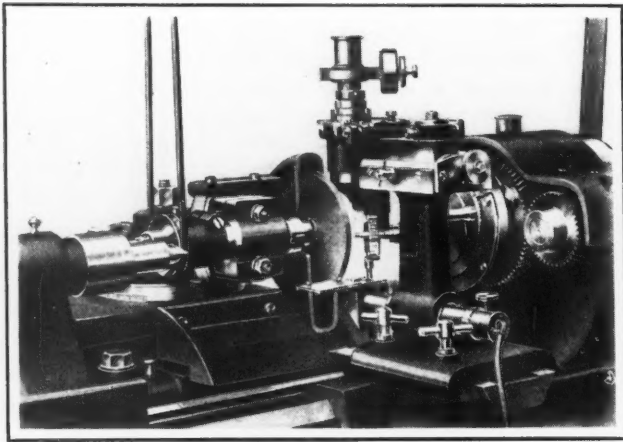


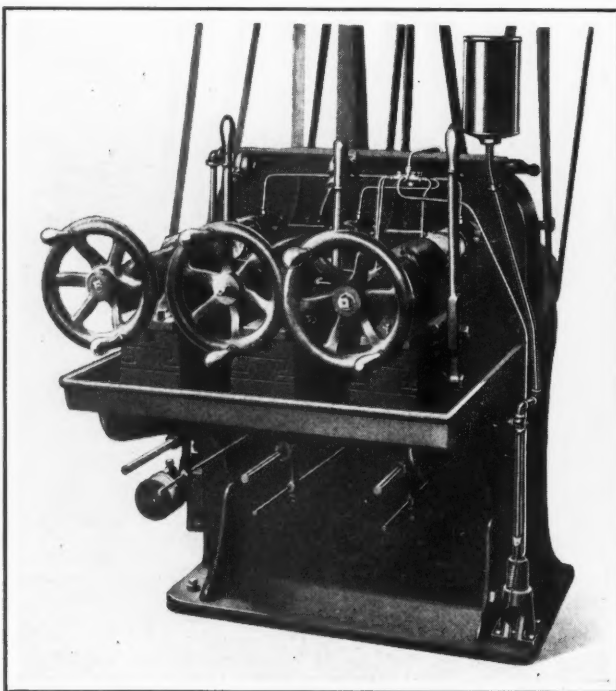
Fig. 2. Measuring Microscope and Dividing Head on Faceplate, at Rear of Machine

inches in diameter. The lead-screw of the machine has five threads per inch. Change-gears take care of pitches from 26 to 3 threads per inch, and metric pitches of from 0.8 to 7 millimeters. The distance between centers is 12 inches, and the net weight of the machine is about 1430 pounds.

### BOWEN LUBRICATION SYSTEM

Machine tools and other industrial machinery equipped with a new lubrication system recently brought out by the Bowen Products Corporation, Auburn, N. Y., can be oiled automatically at any number of points by simply depressing a foot-treadle. This method of lubrication obviates the necessity of stopping the machine at intervals for oiling, and practically eliminates the time consumed by the operator in hand-oiling. The accompanying illustration shows a three-spindle tapping machine equipped with this system, the foot-treadle being located at the right-hand corner of the base on the front side.

The equipment consists of a central reservoir and pump with supply lines leading to one or more control headers from which delivery tubes lead directly to the bearings requiring lubricant. The pump is operated by the foot-treadle to force the oil to the control header which, in turn, forces a predetermined quantity of oil into the delivery tubes.

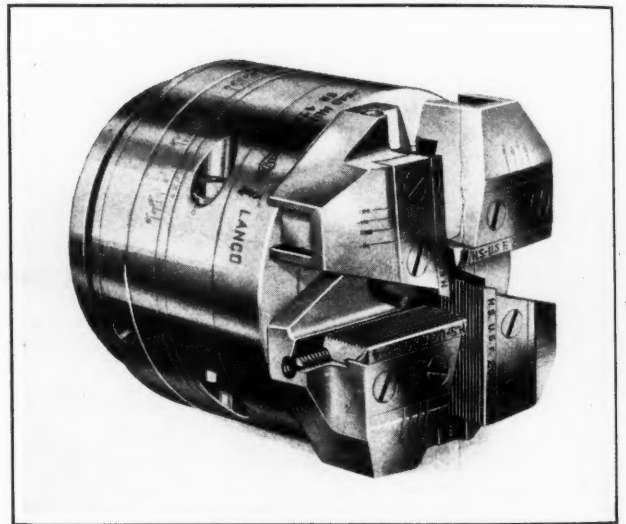


Three-spindle Tapping Machine equipped with the Bowen System of Lubrication

If one of the delivery lines should break, the construction of the control header is such as to prevent the other delivery lines from being affected or the reservoir from being emptied. The delivery lines are made of a heavy-wall copper tubing, sufficiently strong to prevent alteration of the inside diameter, which would decrease the amount of oil delivered through the tube. Should the oil in the system become gummy, it can be readily cleaned out by filling the tank with kerosene, and pumping it through the system. In depressing the foot-treadle, a pressure of 1000 pounds per square inch is developed in the supply lines. If one of the delivery lines should become badly clogged, a much greater pressure is automatically put on that particular line for cleaning it out. Cleaning of the oil is effected by means of a fine-mesh screen in the reservoir.

### "LANCO" DIE-HEAD

A new thread-cutting die-head, known as the "Lanco," which is applicable to all makes of automatic, semi-automatic, and hand-operated threading machines, has recently been placed on the market by the Landis Machine Co., Waynesboro, Pa. The chasers of this head are supported



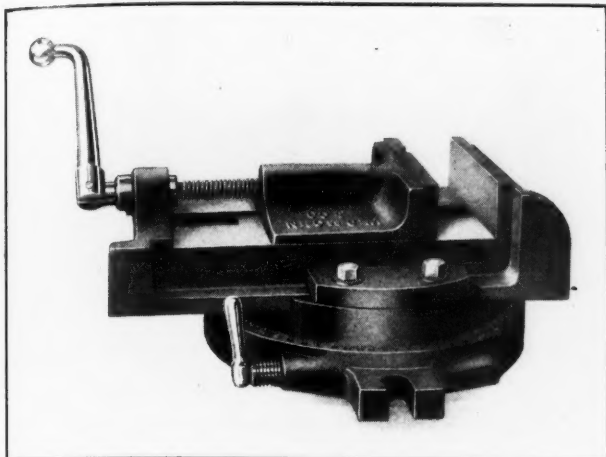
"Lanco" Die-head for Automatic, Semi-automatic and Hand-operated Threading Machines

on the front face, so that they are easily accessible when it is necessary to remove them for grinding or when changing from one pitch of thread to another. The head is made of high-carbon steel, heat-treated throughout and ground.

Adjustment for size is accomplished by means of a worm which is always under the proper turning tension. This arrangement eliminates the necessity of locking the worm after each adjustment. A graduated dial at the end of the worm indicates a variation in adjustment of approximately 0.005 inch for each graduation. When threading, the head is locked within itself by the engagement of two closing pins in hardened bushings. It is opened and closed automatically. The head is graduated for all sizes of bolts, both right- and left-hand, and right-hand pipe threads, within its range. It is made in 3/8-, 9/16-, 3/4-, 1- and 1 1/2-inch sizes. All openings into the interior of the head are entirely covered under service conditions to make it impossible for dirt and chips to enter.

### MOHN SWIVEL VISE

A swivel vise which is designed primarily for use on milling machines, but which is also applicable to drilling machines, is now being introduced to the trade by the Mohn Machine Co., 224-230 Wood St., Reading, Pa. This appliance consists of two units, the Mohn No. 2 universal vise which has been on the market for many years, and an improved



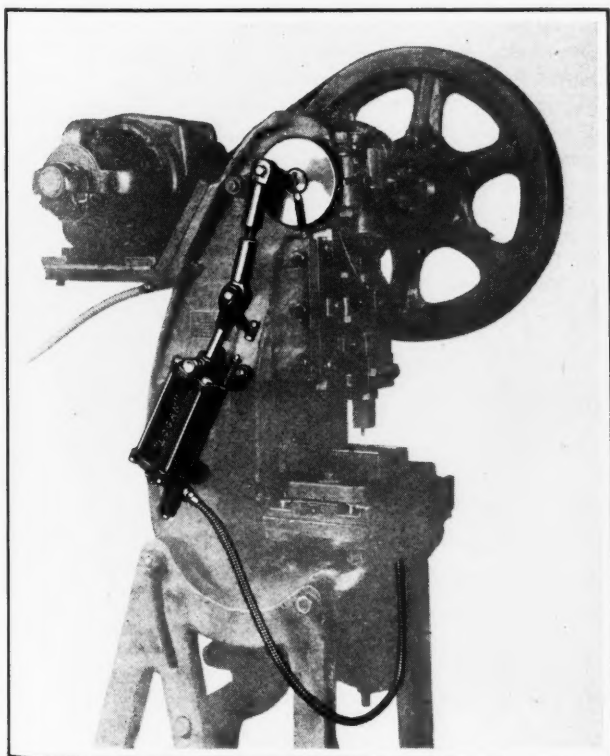
Mohn Swivel Vise with Graduated Base

base. The latter is graduated so that the vise can be set at any angle in a horizontal plane. After loosening two clamps, the vise can be detached from the base for general use on drilling machines. Shops now equipped with the universal vise may mount it on the new base. The width of the jaws is 5 inches, the opening of the jaws, 4 inches, and the weight of the vise complete with the base, about 31 pounds.

### "LOGAN" WORK-EJECTING AIR COMPRESSOR

A pneumatic equipment has recently been brought out by the Logansport Machine Co., 529 Market St., Logansport, Ind., which is applicable to various types of machines, for automatically ejecting work and removing foreign substances from the work and tools. This work-ejecting air compressor is shown in the illustration installed on a punch press. In such an installation, air is compressed on the down stroke of the ram, and automatically released on the up stroke to blow the work into a chute or receptacle. The air blast may be regulated by means of a pet-cock.

Among the advantages claimed for this equipment are the

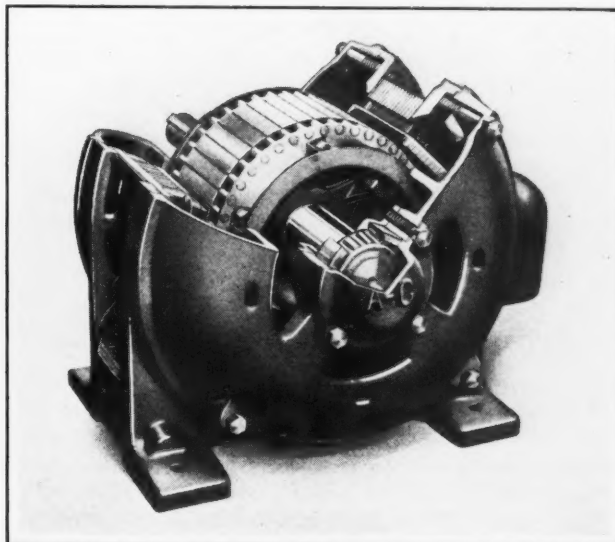


"Logan" Work-ejecting Air Compressor applied to a Punch Press

fact that there is no cost for the air consumed; that production is increased by the saving of time; and that the device is fool-proof, simple in control and operation, and easily attached. The cylinder is regularly furnished with a 3-inch bore, for a 5-inch stroke, for operation at 60 strokes per minute, and to deliver an air pressure of about 60 pounds per square inch. However, the cylinder can also be furnished with a 4 1/2- or a 6-inch bore, and for any required stroke.

### ALLIS-CHALMERS INDUCTION MOTORS

A complete line of 25- and 60-cycle squirrel-cage and slip-ring induction motors, equipped with Timken tapered roller bearings, is being introduced to the trade by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. This new line supplements the sleeve-bearing motors built by the same company. Among the advantages claimed for the roller-bearing motors are the fact that the bearings are able to withstand continued heavy radial and thrust loads without undue heating or appreciable wear; that they are particularly suited for heavy service; and that they operate satisfactorily at the high speeds of the general-purpose induction motor.



Allis-Chalmers Induction Motor equipped with Timken Roller Bearings

Grease is used as a lubricant, the bearings being fully enclosed so as to exclude dirt or abrasive matter which might cause undue wear of the bearings. Both the cone and cup of the bearings are a light press fit, which results in a simple mounting and permits them to be conveniently removed when necessary. The frame of the motor is made of steel with the feet cast integral. This motor is adapted to many applications, because the over-all length is considerably less than that of a sleeve-bearing motor. It is made in sizes up to 200 horsepower.

### HERCULES PORTABLE AIR TOOLS

Two examples of a line of portable air tools recently developed by the Buckeye Portable Tool Co., 131-135 Wayne Ave., Dayton, Ohio, are shown in Figs. 1 and 2. Each tool in this line is so constructed that after air is taken in at the line pressure, there is a 60-degree expansion stroke and then a sudden full opening of the exhaust. There are three pistons, each of which makes two power strokes per revolution. During the operation of a tool, one piston is always taking air from the line, another is acting under the expansion of the air behind it, which has been cut off from the supply line, and the third has just had the air exhausted from behind it. Most models have only four working parts, and lubricant is continuously forced to those parts.

The line of drills consists of the No. 00 drill, which has a drilling capacity up to 1/4 inch, runs at 1800 revolutions

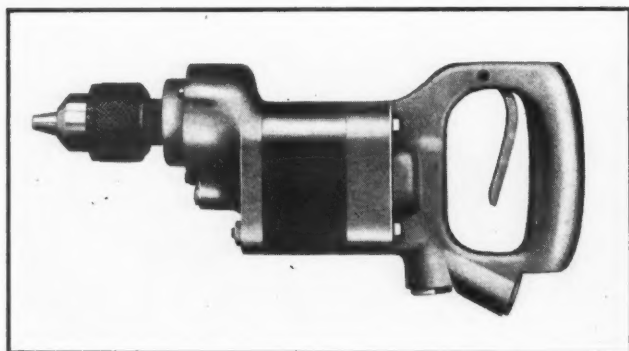


Fig. 1. Hercules Portable Drill

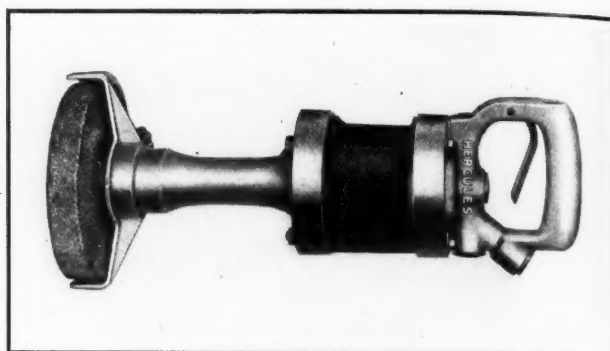


Fig. 2. Portable Grinder or Buffer

per minute, and weights 6 1/4 pounds; the No. 0 drill, shown in Fig. 1, which has a drilling capacity up to 3/8 inch, runs at 1200 revolutions per minute, and weights 9 pounds; and the No. 1-B drill, which has a drilling capacity up to 5/8 inch, runs at 700 revolutions per minute, and weighs 12 pounds. The line of grinders and buffers consists of the No. 7 tool, illustrated in Fig. 2, which has a capacity for 6- by 3/4-inch grinding wheels, runs at 4000 revolutions per minute, and weighs 12 pounds; the No. 5 tool, which is similar to the No. 7 except that it differs in the shape of the rear head and is equipped with a straight twist-throttle instead of the trigger-type throttle set in a spade handle; the No. 6 tool, which has a capacity for 8- by 2 1/2-inch wheels, runs at 6000 revolutions per minute, and weighs 10 1/2 pounds; the No. 20 tool, which receives 4- by 3/4-inch wheels, runs at 6000 revolutions per minute, and weighs 7 pounds; and the No. 11 tool which receives 8- by 1-inch wheels, runs at 3600 revolutions per minute, and weighs 14 pounds.

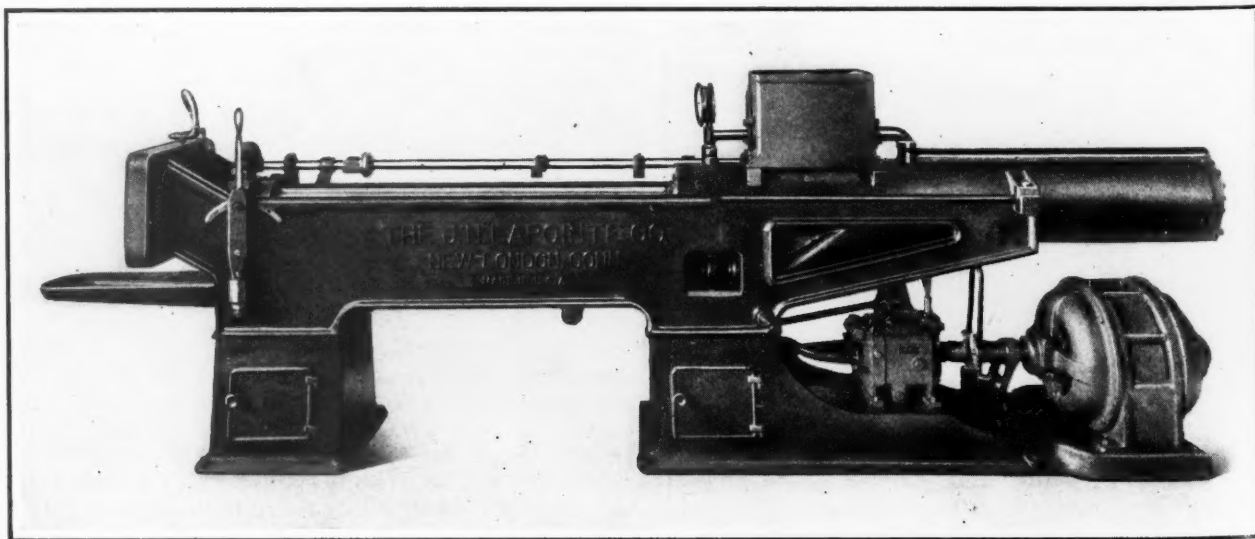
### LAPOINTE HYDRAULIC BROACHING MACHINE

The latest development of the J. N. Lapointe Co., New London, Conn., is the No. 4W hydraulic broaching machine here illustrated, which provides a wide range of cutting speeds of the ram with a positive fast return speed of 60 feet per minute. Pressure is supplied by a No. 5 variable-delivery multi-plunger hydraulic pump manufactured by the Waterbury Tool Co. The speed of the pump is 600 revolutions per minute. Either a countershaft or a direct-motor drive may be used for the pump, but a 10-horsepower motor is recommended. The hydraulic cylinder is 8 inches in diameter, and is mounted on the rear end of the machine bed. At a pressure of 900 pounds per square inch, which is the maximum recommended, and the amount for which a relief

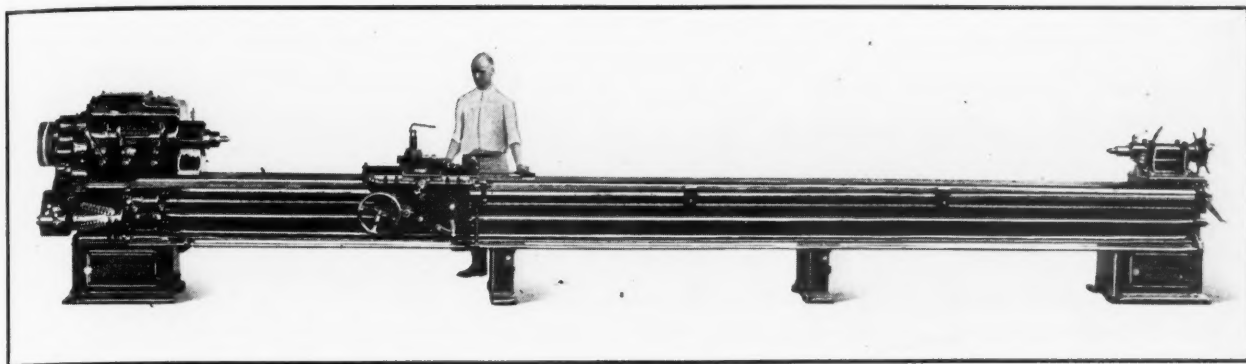
valve in the pump is set, a pull of 43,000 pounds is exerted at the draw-rod. The stroke of the draw-rod is 64 inches, and the cutting speed is controllable from 0 to 24 feet per minute. Cutting speed changes can be made while the machine is running or stopped, and only a few seconds are required to adjust the speed to any predetermined rate. The speed control is mounted on a shaft which runs parallel to the cross-head ways and can be locked for any speed.

This machine is provided with an automatic stop for controlling the length of the stroke. The stop is of the spring and plunger type, and requires no wrenches for adjustment. In varying the length of the stroke, it is merely necessary to slide the stop forward or backward the required distance. The machine can be stopped or started in any position, either on the cutting or the return stroke by means of a hand-lever. A system of linkage connects this lever and the control shaft to the pump control.

The pump is directly connected to an automatic valve which is integral with the pressure cylinder. This valve is so arranged that during the return stroke of the ram, the oil which produces the pressure on the cutting stroke is transferred to the opposite side of the piston without going through the pump. On the return stroke, oil is forced into the hollow draw-rod and works against a 2 1/8-inch diameter surface, producing the rapid travel which is an outstanding feature of the machine. A reservoir is located above the pressure cylinder to accommodate the excess oil during the working stroke, the excess being due to the fact that the piston-rod reduces the total volume, or the working area, on the forward side of the piston. Connections are so arranged that when the relief valves in the pump open under pressure they also exhaust into the reservoir and thus allow the oil to remain in the system. The oil falls and rises in the reservoir at each stroke of the machine, due to the differences in the working area of the pressure cylinder on the two sides of the ram. The reservoir also provides a means



Lapointe Hydraulic Broaching Machine with a Return Stroke of 60 Feet per Minute



Lehmann Geared-head Lathe with Long Bed

of readily filling the system, about twenty-four gallons of oil being required for filling.

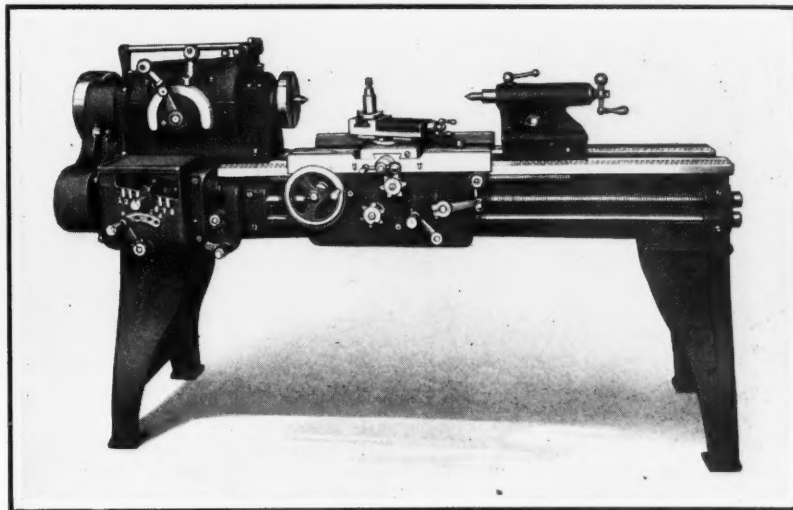
The system is open to the atmosphere at all times through the reservoir which, being the highest point, eliminates any possibility of air accumulating in the system. The draw or sliding head is fitted with bronze shoes to reduce wear and insure alignment. Cutting lubricant is supplied to the broach as it enters and leaves the work, by a No. 3 Brown & Sharpe geared pump. The floor space occupied by this machine is 15 feet by 25 inches, and the weight, about 7600 pounds.

### CARROLL & JAMIESON ENGINE LATHES

Two engine lathes, built in 15- and 16-inch swings, respectively, with either a geared headstock or a three-step cone and double back-gears, are being introduced to the trade by the Carroll & Jamieson Machine Tool Co., Batavia, Ohio. Twelve spindle speeds, ranging from 11 1/2 to 393 revolutions per minute, are available through the geared headstock by operating two levers. Lubrication of the headstock is accomplished by the splash system. A friction clutch and brake are operated by one lever to give instant control of the spindle, and changes in speeds can be made while the machine is in operation.

The carriage is equipped with a special clamp for securing it to the bed in facing operations. Both the cross-slide and compound rest are fitted with adjustable tapered gibs. The apron is of the double-wall type, so as to support the gear studs at both ends. Oil reservoirs in the wall of the apron deliver lubricant to each bearing through tubing. A thread indicator is furnished. The feeds required in cutting threads of from 3 to 46 pitch are obtained through the operation of two levers on the quick-change gear-box, while a quadrant is provided to accommodate gears necessary for special threads.

A motor drive may be arranged by placing the motor in a cabinet leg and driving through a belt. A feature of the lathe is the method of assembling the gear-box and the lead-screw block by bolting them to a machined pad on the side of the bed, in which a master slot is cut to correspond with a key in the parts mentioned. This locates those parts in line and makes them interchangeable on all machines. The machines may be provided with 6-, 8-, 10-, 12- or 14-foot beds. With a 6-foot bed, the distance between centers is 38 inches.



Carroll &amp; Jamieson Engine Lathe

### LEHMANN GEARED-HEAD LATHE

A geared-head engine lathe of 24-inch rated swing, with a bed 27 feet long, is shown in the accompanying illustration. The actual maximum swing is 27 1/8 inches, and work up to 21 feet in length can be held between centers. This machine was recently built by the Lehmann Machine Co., 3571 Chouteau Ave., St. Louis, Mo., for use in the oil industry, and hence it is equipped with the Lehmann improved oil-country taper attachment and a tailstock particularly suited to the work for which the machine is intended. With the exception of the bed length and the cabinet legs, the machine is similar in design to that described in January, 1921, MACHINERY.

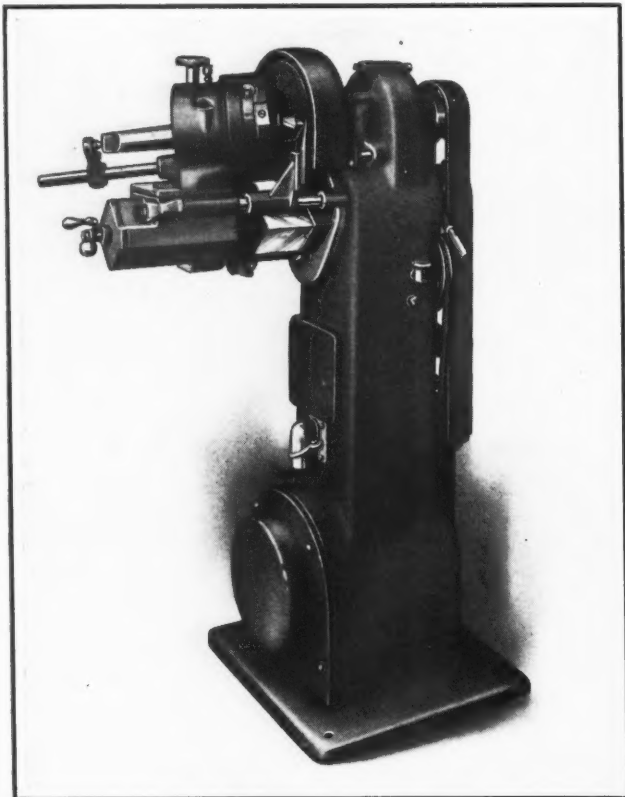
### OLIVER IMPROVED DRILL POINTER

A drill pointing machine which has recently been developed by the Oliver Instrument Co., 1410 E. Maumee St., Adrian, Mich., incorporates many improvements over past designs built by this company. One of the important features is that the grinding time has been greatly reduced, the drill now being rotated continuously instead of intermittently. Bent drills may be satisfactorily ground, as the drill is now held at the point close to the grinding wheel, whereas it was previously held by the shank. There are two jaws in the chuck for holding the drill, which can be centered or adjusted off center as desired. In the grinding, a drill point is produced which is strengthened slightly next to the cutting edge; otherwise, the drill point is the same as produced with the former machines. The lip rest for the drill is now operated through a lever in back of the drill-holder spindle, which is more convenient for the operator.

Another important change is the elimination of the rocker arm, the cross-motion of the wheel being obtained by means of an eccentric quill. The in and out motion formerly obtained through the rocker shaft is now secured by means

of a cam on the quill. This clearance cam is concentric with the wheel-spindle, and eliminates the possibility of lost motion between the cam and drill. Truing of the emery wheel is now accomplished with a dresser mounted on the carriage, which is adjustable through the carriage feed-screw. The wheel guard has been redesigned to direct the sparks and emery away from the machine.

The machine is driven by a motor in

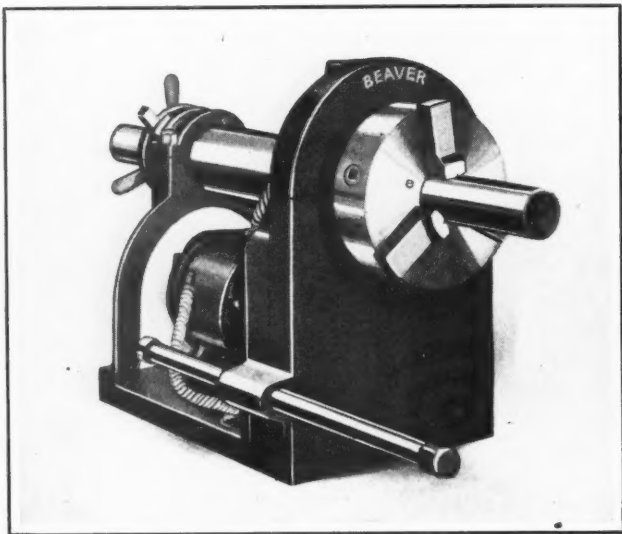


Oliver Drill Pointer of Improved Design

the base direct through shafts and helical gears without the use of the former universal joints. The operating lever and setting gage are both on the right-hand side. All parts of the driving mechanism, including the feed-screw and nut, are protected from dirt, and forced-feed lubrication is furnished to all gears and bearings by a pump in the housing. The machine is built in several sizes for grinding drills up to 3 inches. Change-gears permit the grinding of two-, three- and four-flute drills on the larger sized machines.

### BEAVER POWER DRIVE

A No. 44 motor-driven portable machine has recently been developed by the Borden Co., Warren, Ohio, for regular use in cutting and threading from 1/4- to 2-inch pipe, while using any type of hand-operated pipe-cutters or die-stocks. By means of a universal sliding extension shaft, pipe up to and including 6 inches may be cut and threaded by using geared cutters or die-stocks. In the operation of this power

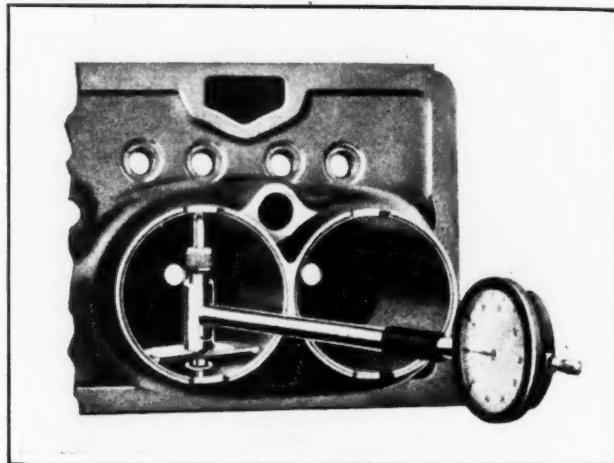


Beaver Power Drive intended for Use in cutting and threading Pipe

drive, the pipe is inserted in the machine, and rigidly held by a universal chuck. The cutter or die-stock is then placed on the pipe, as in cutting or threading by hand, but with the handle of the tool resting on a sliding bar at the side of the machine. When the current is turned on, the pipe revolves while the tool stands still. This equipment may also be used to make up fittings right in the machine. The drive is portable, weighing about 230 pounds. It is regularly equipped with a 1/2-horsepower alternating-current motor for operation from an ordinary light socket; however, special motor equipment can be provided for use in installations where the standard equipment is not suitable.

### SELF-CENTERING INTERNAL INDICATOR

A self-centering measuring device for accurately determining the diameter of automobile cylinder bores, bearings, bushings, etc., has recently been brought out by Carl Mahr, Esslingen, a. N., Germany. Measurements of vertical holes are made by swinging the projecting end of the instrument back and forth like a reversed pendulum, to advance the instrument along the axis of the bore. In the case of a horizontal hole, such as illustrated, the projecting end of the device is swung up and down. As the instrument is advanced, the diameter of the bore is clearly read from the



Mahr Self-centering Instrument for measuring Cylinder Bores. Bearings, Bushings, etc.

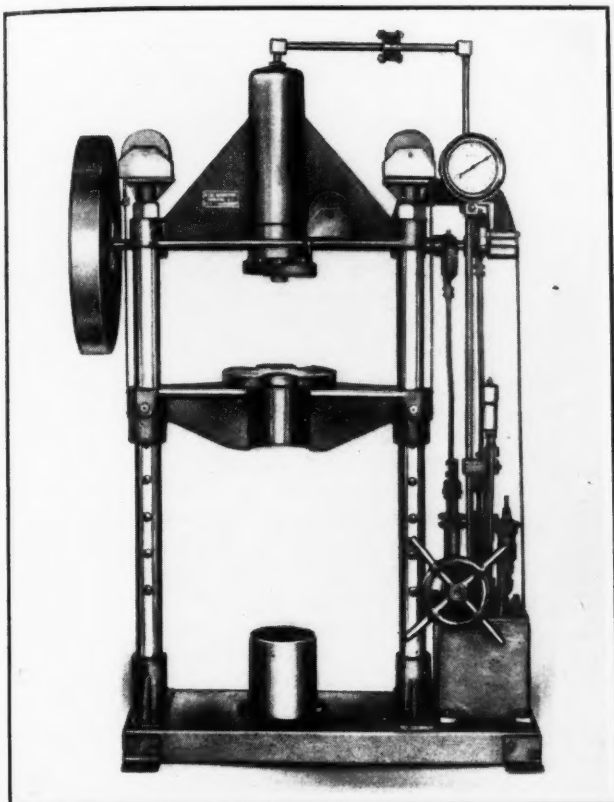
indicator. Any error in size or out-of-roundness is shown in thousandths of an inch.

The instrument can be employed for measuring holes of different sizes in succession. Settings of the instrument may be conveniently made by means of a standard ring gage, in which case the measuring end of the device is inserted in the gage and the dial of the indicator turned to make the needle register zero. When a suitable ring gage is not available, the instrument may be set with a snap gage, end measuring blocks, or a micrometer gage. Various sizes of this instrument are made for measuring holes from 13/16 inch to 16 inches in diameter, and from 7 to 20 inches deep.

### MCCALL "HYDROPRESS"

A 15-ton hydraulic press has been brought out by the McCall Machine Works, Rochester, N. Y., for use in production work or in any of the numerous jobs about the shop requiring such a machine. It may be used for pressing gears on or off shafts, pressing bushings into motor housings, straightening shafts, push-broaching, unit assembly where pressure is required, etc.

The cylinder is made of steel, and is provided with a U-leather packing and a removable gland. The ram is 4 inches in diameter and has a travel of 15 inches. It is returned by means of springs. The strain bars are 3 inches in diameter, and are drilled accurately, so that when pins are in-

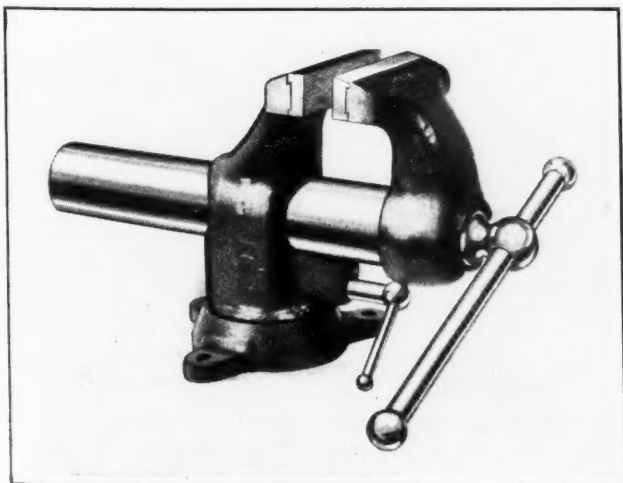


McCall "Hydropress" equipped with a Gage which shows the Pressure in Pounds per Square Inch and in Tons

served in the holes, the resistance beam is square with the ram. The resistance beam is a steel casting of ample cross-section to resist a full 15-ton thrust. It is machined on the top surface, and has a turret with different openings. Springs counterbalance the beam to facilitate hand movement up and down. The pump is of the two-stage type, a large plunger being used to move the ram to the work rapidly. Then the liquid is by-passed to the water box, while a smaller plunger raises the pressure as desired. A bronze safety valve, adjustable to any required pressure, prevents overloading of the machine. A gage is furnished that gives the pressure in pounds per square inch, as well as in tons. The weight of this press is approximately 1100 pounds.

### "DROPFO" BENCH VISE

A vise made entirely of drop-forgings, with the exception of the handle, is being placed on the market by the Fulton Drop Forge Co., Canal Fulton, Ohio, under the trade name of "Dropfo." Each part of this vise is machined to be inter-



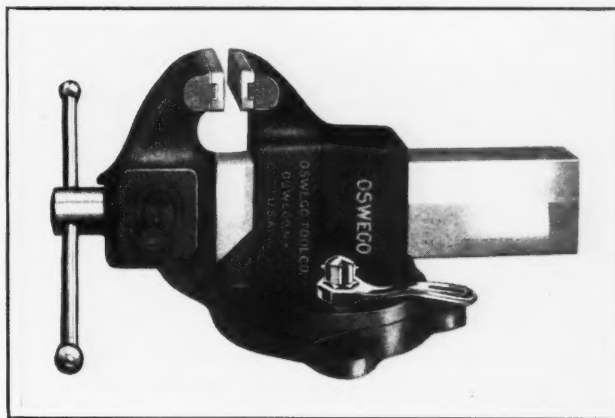
"Dropfo" Bench Vise made of Drop-forgings

changeable with the same part on any other vise of the same size. The jaw plates are knurled and forged under the hammer and doweled on the jaw, so that it is possible to replace the jaw plates as they become worn. The vise is made with a swivel base and wedge lock which is quickly set and is automatic in tightening up. It is also made in a stationary type. Lightness is one of the advantages claimed for this vise. It is made in four sizes as follows: 3-inch, with the jaws opening 5 1/2 inches; 4-inch, with the jaws opening 6 inches; 5-inch, with the jaws opening 8 inches; and 5-inch, heavy-duty, with the jaws opening 8 inches.

### OSWEGO BENCH VISES

A new line of stationary and swivel-base bench vises is being introduced to the trade by the Oswego Tool Co., Oswego, N. Y., in a full range of standard sizes. The gray iron castings are equipped with removable steel-faced jaws made of a chrome-molybdenum alloy steel. These jaws are finely cross-hatched in order to give the greatest grip without marring the piece being held. The screw is made of solid steel throughout to obtain strength with light weight.

Attention is called to the patented improved side nut, which is composed of a special hexagon nut with an inserted pin. A wrench enables the operator to move the nut into any desired position, and the wrench can then be



Oswego Bench Vise with Improved Side Nut

thrown back against the vise, out of the way. However, the wrench cannot be removed from the nut, and is therefore always ready for use when needed. With this design of nut there is no interference with the operation of the vise.

### KELLER AUTOMATIC TOOL-ROOM MILLING MACHINE

A type BL automatic tool-room milling machine, which has just been brought out by the Keller Mechanical Engineering Corporation, 70 Washington St., Brooklyn, N. Y., combines the well-known features of Keller automatic machines with those of the standard milling machine. This machine is well adapted for such operations as machining dies for blanking, trimming, embossing, forming, punching, forging, and molding; punches; pressure pads; cams; templates; gages; jigs; form cutters; metal core-boxes; patterns; match plates; and, in fact, any machined part of irregular surface within its range. Plain drilling, face milling, jig boring, reaming, gear-cutting, etc., can also be done conveniently. The machine has a longitudinal travel of 16 inches and a cross movement of 8 inches, with an additional spindle adjustment. There is a choice of a full-automatic electrical control with automatic operation in three directions, or a semi-automatic electrical control with automatic operation vertically and horizontally and with cross-adjustment by means of a hand control. Handwheels are provided for all three movements. All controls are so situated

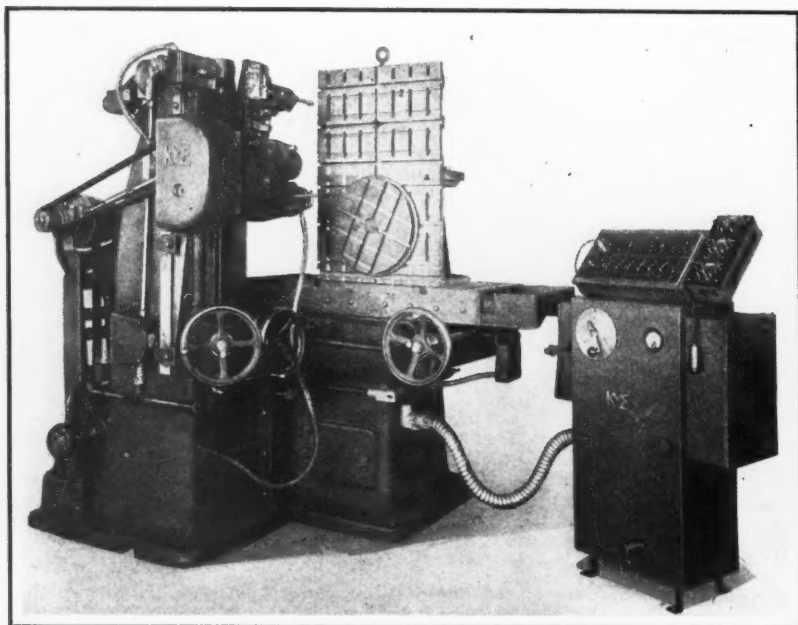


Fig. 1. Keller Automatic Tool-room Milling Machine

as to make it easy for the operator to follow the work from his position.

To use the machine for a milling operation, an over-arm is supplied, which is rigidly clamped in a bearing in the saddle. The arbor is inserted in the spindle in the usual way, and can be supported either at the end or anywhere along its length. Micrometer stops can be supplied for use in jig boring, provision being made for them in the table and column. For cutting blanking dies, punches, or other contour jobs, the master may be a thin metal templet, a part previously made, or a tool of the correct outline, but differences in dimensions can be taken care of by proportionate variations in the relative sizes of the tracer and cutter. For cutting cavities or reliefs with the full-automatic control, the master may be made of an easily molded or shaped material such as lead, cement, plaster, or wood.

The spindle drive is through wide belts running on four-step cones. There is a simple provision for maintaining the

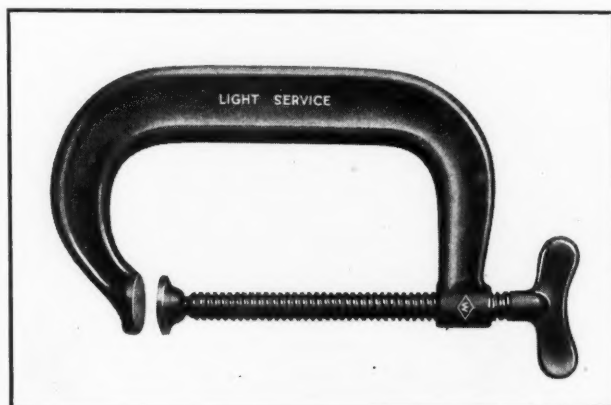
correct belt tension. Twelve different spindle speeds, ranging from 80 to 3600 revolutions per minute, are obtainable. Power for the cutter is supplied by a two-horsepower constant-speed motor mounted on the base of the machine. Each movement has an individual driving unit which is actuated by a 1/4-horsepower ball-bearing variable-speed motor mounted at the end of its respective lead-screw. The oil-pump is also driven by a 1/4-horsepower ball-bearing motor.

The high-speed spindle is equipped with roller bearings, and is bored for a No. 7 B. & S. taper shank, while the standard slow-speed spindle runs in bronze bushings, and is bored for a No. 9 B. & S. taper shank. A third spindle, bored for a No. 12 B. & S. taper shank, can be supplied. All slides have widely spaced supporting bearings and two narrow parallel guides running on each side of the lead-screw to prevent jamming and insure alignment. Gibs are provided on guides and bearings to take up wear. Lubrication of moving parts is accomplished through sight-feed oil-cups and by packing

the ball bearings. The base casting weighs about 1180 pounds; the column with the vertical slides carrying the saddle and spindle head, about 1320 pounds; and the complete machine, approximately 7500 pounds.

## WILLIAMS AUTOMOBILE BODY MAKERS' C-CLAMPS

A new line of C-clamps has recently been placed on the market by J. H. Williams & Co., Buffalo, N. Y. These clamps are especially designed for the use of automobile body mak-



Williams C-clamp made of Drop-forgings

ers, but they also have a large variety of applications in the metal- and wood-working industries. The clamps are made in different sizes, ranging from 4 to 10 inches. They are drop-forged from a special steel that is said to give the desired strength with the minimum weight, and are heat-treated to obtain maximum stiffness. The throat is deep, to provide ample clearance. The screws are drop-forged in one piece, without a separate handle or wings that can become loose. They are recessed and rounded to furnish an easy hand grip, and are threaded to permit rapid adjustment.

## "LO-SWING" LATHE IMPROVEMENT

An important improvement made in all "Lo-Swing" lathes, which are built by the Seneca Falls Machine Co., Seneca Falls, N. Y., consists of the provision of hardened steel plates or strips on the carriage ways with a view to reducing wear to a minimum. The strips are made from a low-carbon steel.

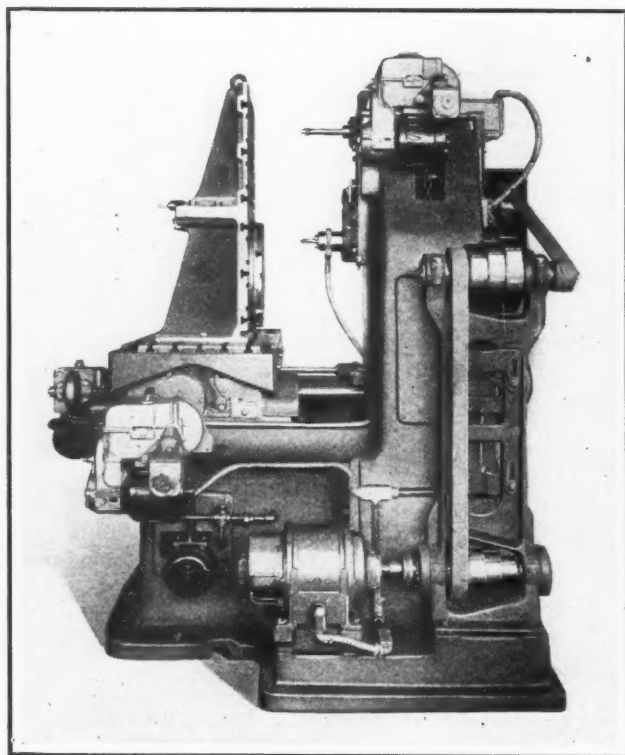
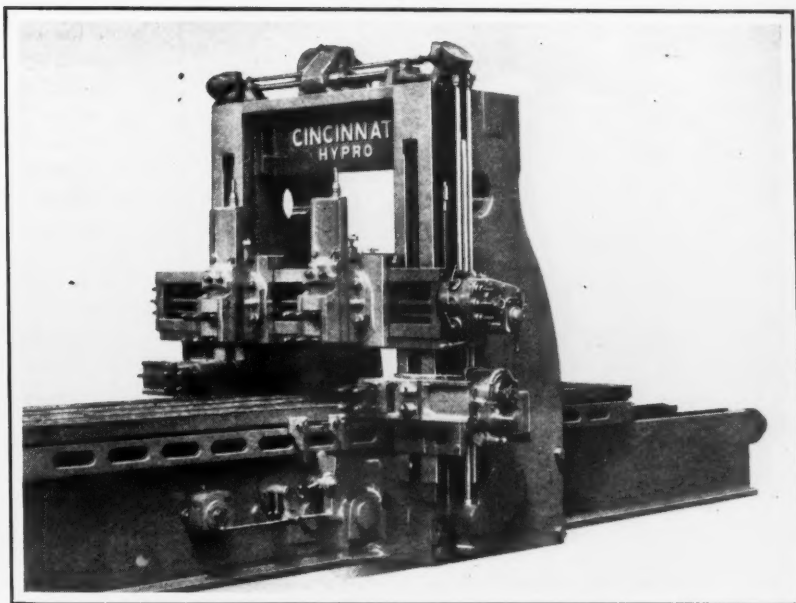


Fig. 2. Rear View of Machine, showing the Individual Drives

carburized and hardened, with one side left soft. They are then straightened and ground on a Blanchard grinder, and attached to the lathe in such a way that the screw heads are left flush. After the plates are in position, they are ground true with the rest of the machine, gages being used for inspecting their accuracy. Finally, the carriage is scraped to the plates.

### CINCINNATI "HYPRO" PLANER

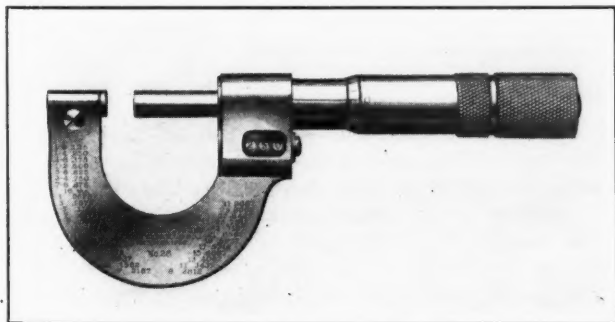
A 48-inch size has recently been added to the line of "Hypro" planers built by the Cincinnati Planer Co., Cincinnati, Ohio. The features of this machine are the same as those of the 36-inch size which was described completely in April MACHINERY. All heads can be moved in each direction independently of each other by means of the rapid traverse, or engaged at the same time. The feeds are also independent. A safety device eliminates accidents if the heads should be fed together. A selective dial feed is provided for each head, a knob being given a single turn to obtain a range of feeds from 0 to 1 inch. A safety trigger gear has been placed on the rail and side heads. The rail is clamped to the inside face of the housing by a device that is operated by a crank-handle at the end of the rail.



Cincinnati 48-inch "Hypro" Planer

The design of the rolls has been changed so that the large end is at right angles to the center line of the roll. Thus, the contact between the large end of the roll and the rib of the cone is in two areas, the cone rib being slightly undercut. It is claimed that this two-area contact insures axial alignment between the center line of the roll and the center line of the bearing at all times, and a true line contact between the surface of the roll and the surface of the cone and between the surface of the roll and the surface of the cup. An added purpose served by the two-area contact is self-alignment of the rolls on the cone and in the cup. Skewing of the roll on the cone raceway is impossible, since the two areas on the end of the roll make generously separated points of contact with the shoulder or rib of the cone, as shown in Fig. 1.

Previously, the cage was cold-pressed into the shape of a cup, the bottom stamped out, and the pockets for the rolls punched out one at a time in an automatic punch press. The result was uniformity of the cage pockets; yet a progressive error was present in the alignment due to stretching of the metal as the indexing fixture advanced the cage to the final perforation. To correct this microscopic error, a multiple perforating die was developed which perforates all roll pockets in the cage by a single impact. To further safeguard against any possibility of error in this operation, due



Brown & Sharpe Direct-reading Micrometer

This instrument resembles the bright-frame 1-inch micrometer made by the same company, and can be operated with one hand. The advantages claimed are that time is saved, because it is not necessary to make mental calculations, and that there is no chance of making errors in readings. When it is necessary to compensate for wear of the adjusting screw, a cap is removed from the end of the thimble and the adjusting nut is then accessible through an opening in the thimble.

### TIMKEN IMPROVED TAPERED ROLLER BEARING

An improved type of tapered roller bearing has just been brought out by the Timken Roller Bearing Co., Canton, Ohio, which differs from the well-known bearing in major refinements, but retains all the essential elements. Nickel-molybdenum steel of a special formula has been adopted for all bearings, this steel being said to possess properties of grain texture and toughness which reflect favorably in the life of anti-friction bearings.

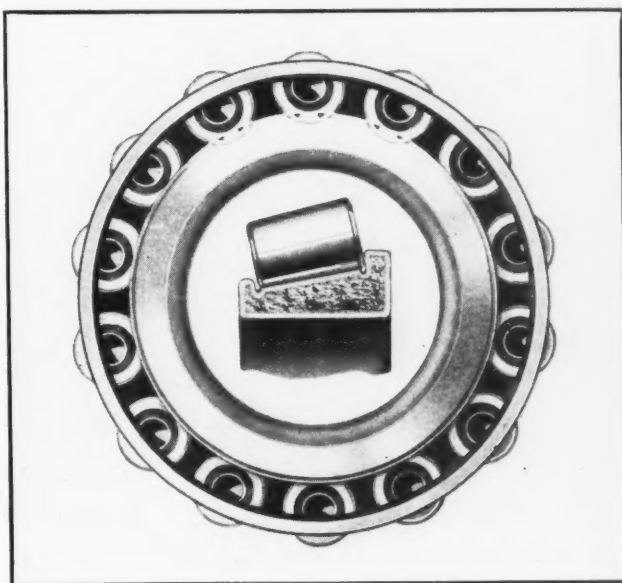


Fig. 1. Timken Improved Tapered Roller Bearing

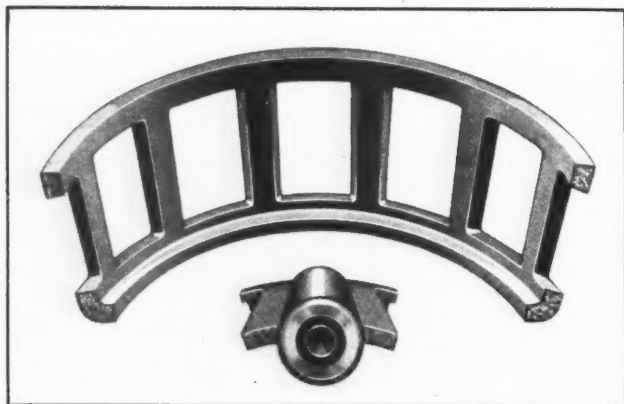


Fig. 2. Details of Construction of the Improved Timken Bearing

to distortion, an inwardly turned flange has been retained on the smaller side of the cage.

To insure smoothness and accurate feed of the rolls in the cage, the lateral edges of the cage are swaged inward, so that the contour of the sides of the cage pocket conforms to the contour of the roll. This operation is termed "winging," and dies similar to the multiple perforator are used to wing all the pockets simultaneously. The inwardly turned flange and the result of the winging operation are shown in Fig. 2. The self-aligning principle and the accurately perforated cage are said to reduce the noise in the bearing to a marked degree. It is also mentioned that the already low coefficient of friction in previous designs has been reduced in the new bearing. The self-aligning properties of the rolls relative to the cone face also permit much higher speeds. These various refinements make the improved bearing adaptable to all industrial uses and particularly to the high speeds common in machine tools.

### COCHRANE-BLY COLD AND AUTOMATIC SAWS

In cutting I-beams, channel irons, and similar parts, at 45-degree and other angles, it is necessary to have either a large blade or a long carriage travel. For such operations, the Cochrane-Bly Co., Rochester, N. Y., has developed a machine with a saw travel of 48 inches. As on the standard machines built by this company, the feed-screw is mounted above the ways and close to the saw blade, so as to bring the feed thrust nearly in line with the blade resistance. In sawing an I-beam or channel iron on the top table, shown in Fig. 2, the carriage passes under the work. It is stated that the position of the feed-screw, therefore, tends to eliminate cant of the carriage and the accompanying vibration.

In cutting light sections, only one tooth of the blade is engaged in the metal at one time, which would tend to cause chatter, vibration, and rapid dulling of the blade, except that the saw arbor is geared to a

band brake, which takes up all slack in the gear teeth and holds the blade steady. The upper table can be removed, as shown in Fig. 1, after which the machine has a capacity for cutting 21-inch I-beams in the vertical position or round bars up to 10 inches in diameter.

The machine is driven through a friction clutch and a sliding gear transmission, the hardened nickel-steel gears running in an oil bath. Cutting speeds of 30, 40, and 50 feet per minute are obtainable. The feed is geared and provides eleven changes varying from 1/2 to 2 1/2 inches per minute. In addition, there is a rapid power traverse to the carriage in both directions. The friction clutch, feeds, and rapid traverse are under instant control from either the front or rear working positions.

Some of the principal specifications of this machine are as follows: Capacity of top table, for flat sections, 36 inches; vertical sections, 9 1/4 inches; I-beams square-cut, 36 by 8 3/4 inches; and I-beams miter-cut, 25 by 8 3/4 inches. On the bottom table the capacity for cutting vertical I-beams square, is 21 by 8 inches, and miter, 15 by 7 inches. The machine weighs about 15,000 pounds.

The Cochrane-Bly Co. has also recently developed the No. 21-SA automatic cut-off saw illustrated in Fig. 3. This

machine is designed primarily for cutting bars, tubes, and extruded sections of non-ferrous metals, but it can also be used for cutting wood, fiber, hard rubber, bakelite, etc., or by the use of an abrasive disk, such materials as magnet steel, hardened drill rod, tool bits, and porcelains can be cut. The machine illustrated has a pump and tube connections to the blade housing for deliver-

ing a jet of oil or compound on each side of the blade close to the collars. Centrifugal force distributes the lubricant so as to cool the entire blade and lubricate the teeth. There is a reservoir in the column, which holds a liberal supply of the liquid.

The carriage has a travel adjustable from 1/2 to 4 1/4 inches, and a speed range giving eighteen changes varying from 1 to 30 strokes per minute. The carriage is also adjustable in relation to the vise, so as to compensate for wear of the blades and for varying positions of the work in the vise. The latter is operated automatically in time with the movement of the carriage, and will accommodate work 4 inches in diameter. The movement of the vise jaw can be varied from 0 up to 1/2 inch.

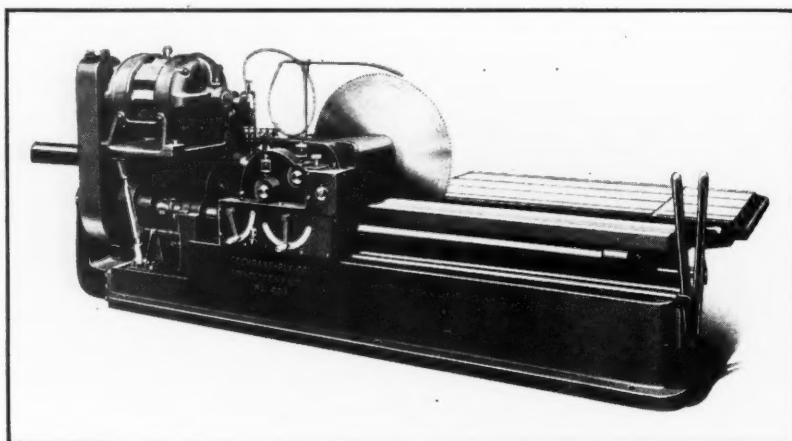


Fig. 1. Cochrane-Bly Combination Cold Saw

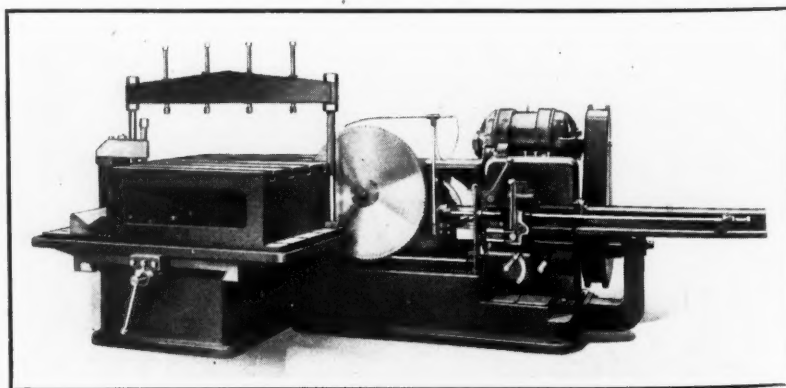


Fig. 2. View of Saw with Top Table in Place

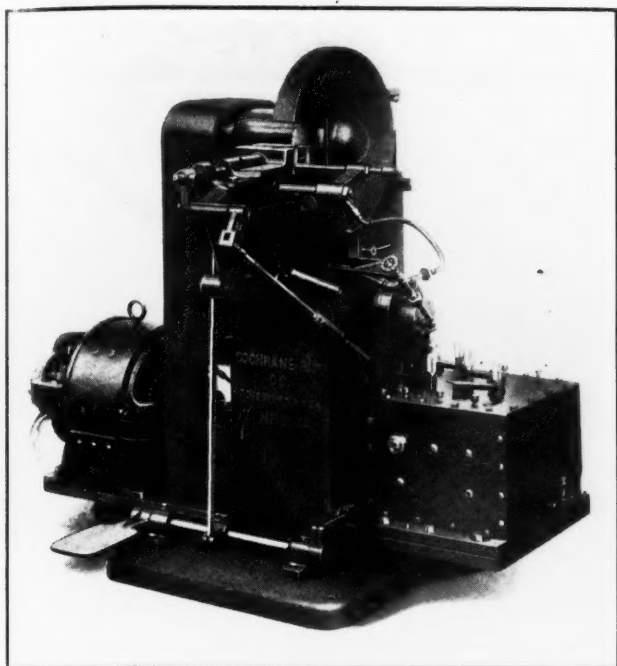
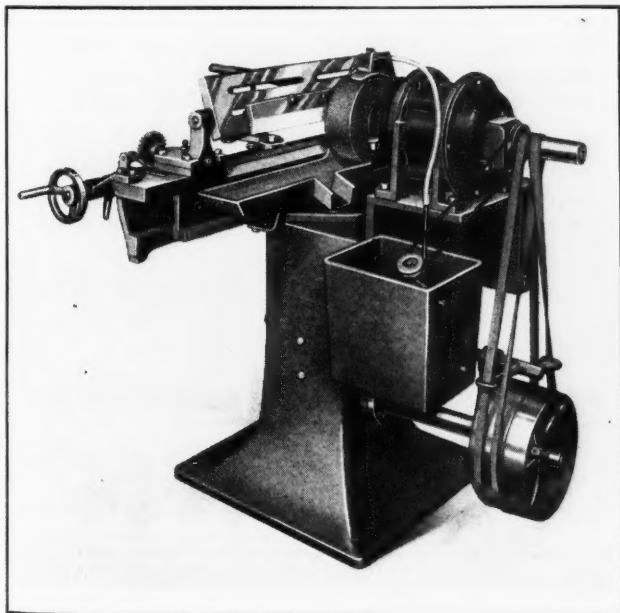


Fig. 3. Automatic Cut-off Saw designed primarily for cutting Bars, Tubes, and Extruded Sections of Non-ferrous Metals

Timken roller bearings mounted in dustproof cases are provided for the spindle. There is an automatic positive clutch, which is engaged by means of the foot-treadle. If the treadle is released, the machine will make one stroke and stop with the blade in the back position, but if the treadle is held or locked, the machine will run continuously. Through the operating cams speeds up to 120 strokes per minute are available, and automatic feeds can be provided for special jobs. Arranged with a belt drive, this machine weighs about 2150 pounds.

### ROGERS MOTOR-DRIVEN KNIFE GRINDERS

A line of automatic-feed knife grinders equipped with direct-connected motor drives has just been placed on the market by Samuel C. Rogers & Co., 20-24 Lock St., Buffalo, N. Y. These grinders are made in five sizes for knives up to 1/2 inch thick and 54 inches long. They may be used in

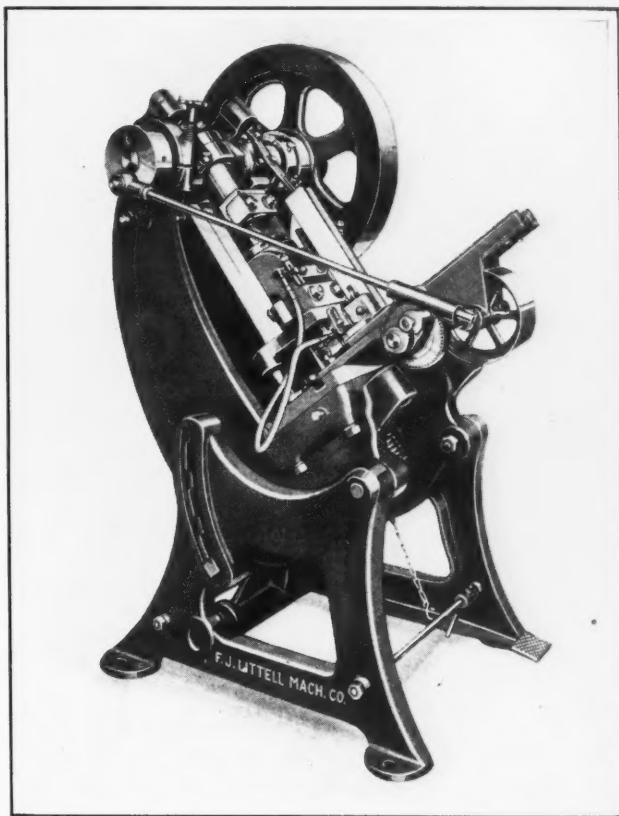


Rogers Motor-driven Knife Grinder

grinding wood planer knives of the thick, slotted type, as well as thin high-speed knives that do not have slots. Thin knives can be ground quickly by using a gage attachment which takes the place of the combination knife bar. By mounting the motor directly on the shaft of the grinding wheel, a positive fixed speed is obtained. The starting switch is attached to the grinder directly under the motor, to eliminate unnecessary wiring and place the switch in a convenient position for the operator. A standard one-horse-power motor is used.

### LITTELL AUTOMATIC MAGAZINE FEED

Most accidents in punch press departments occur while operators are feeding forming dies. To obviate these accidents and at the same time to permit increased production rates, the F. J. Littell Machine Co., 4125-27 Ravenswood Ave., Chicago, Ill., has developed an automatic magazine feed that



Littell Automatic Magazine Feed for Inclined Power Presses

is applicable to punch presses fed while in an inclined position. With this magazine feed, there is no danger to the operator.

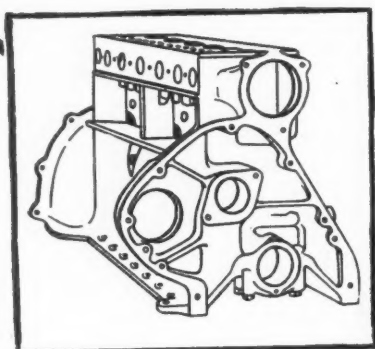
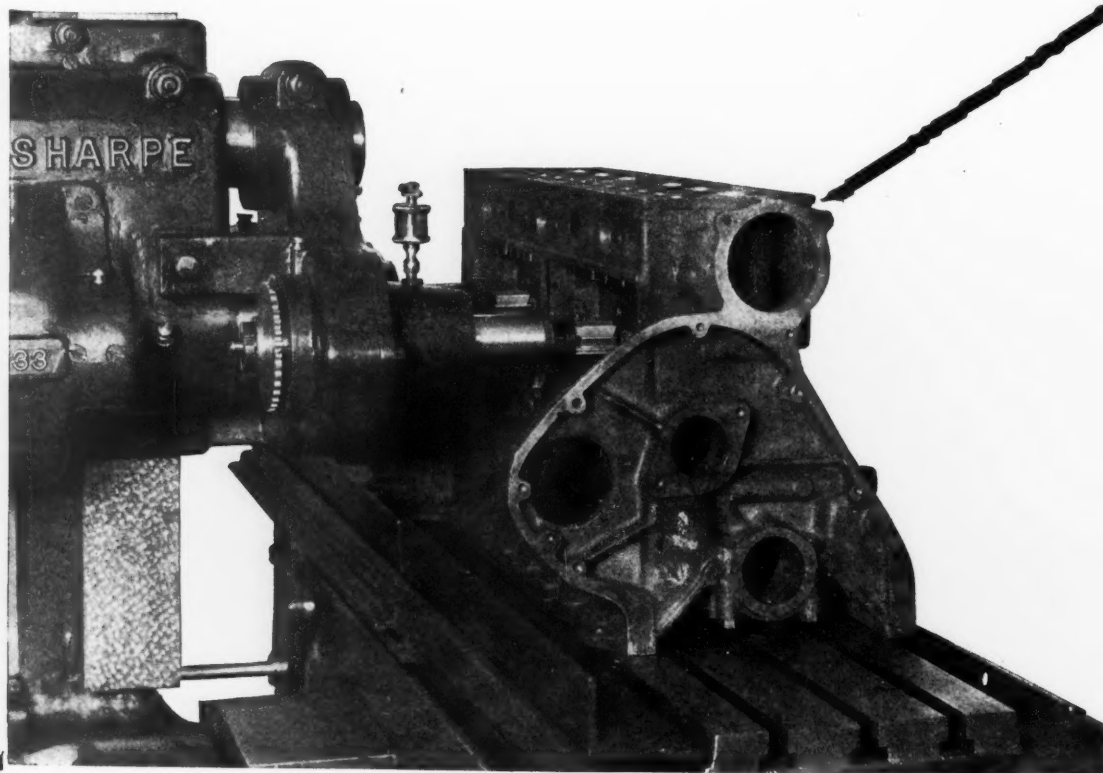
A long stroke is used, so that the work is pushed from the magazine directly to the die without stopping at intermediate stations, and one piece does not push another ahead of it. In case a blank should lock in the magazine, a spring pin is unlatched to stop the magazine from feeding and prevent the breakage of parts. As soon as the piece is cleared, the machine is ready to run again.

After the forming operation, the piece is lifted out of the die by the punch or blown out by air. In most cases it is better to lift the work with the punch, using the bar knock-out in the slide for pushing the piece off the punch and then blowing it clear with air. Inasmuch as various shaped magazines and pushers can be used with the automatic feed, this device is adaptable to feeding a wide range of forming work. It is mentioned that the rate of production can be materially increased, because the feed operates at every stroke of the press, and many pieces can be produced at the rate of from 70 to 75 per minute.

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## AUTOMATIC MILLING MACHINES

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### Automatic Machines "Automatic" —put a No. 33 Automatic on t

**B**UILT to increase production and lower operating costs, the No. 33 Automatic Milling Machine is a sturdy, modern production unit of the highest calibre.

With a reversible spindle and table that are independently and automatically controlled by table dogs, a work holding fixture is usually placed at each end of the table. This permits one fixture to be loaded while the work in the other fixture is being milled. Such a method of milling is illustrated at the upper right.

In addition to the high production method mentioned above, there are further production possibilities for many jobs where the work will not permit the use of two fixtures. Shown at the upper left is a job where

Brown & Sharpe Mfg. Co.,

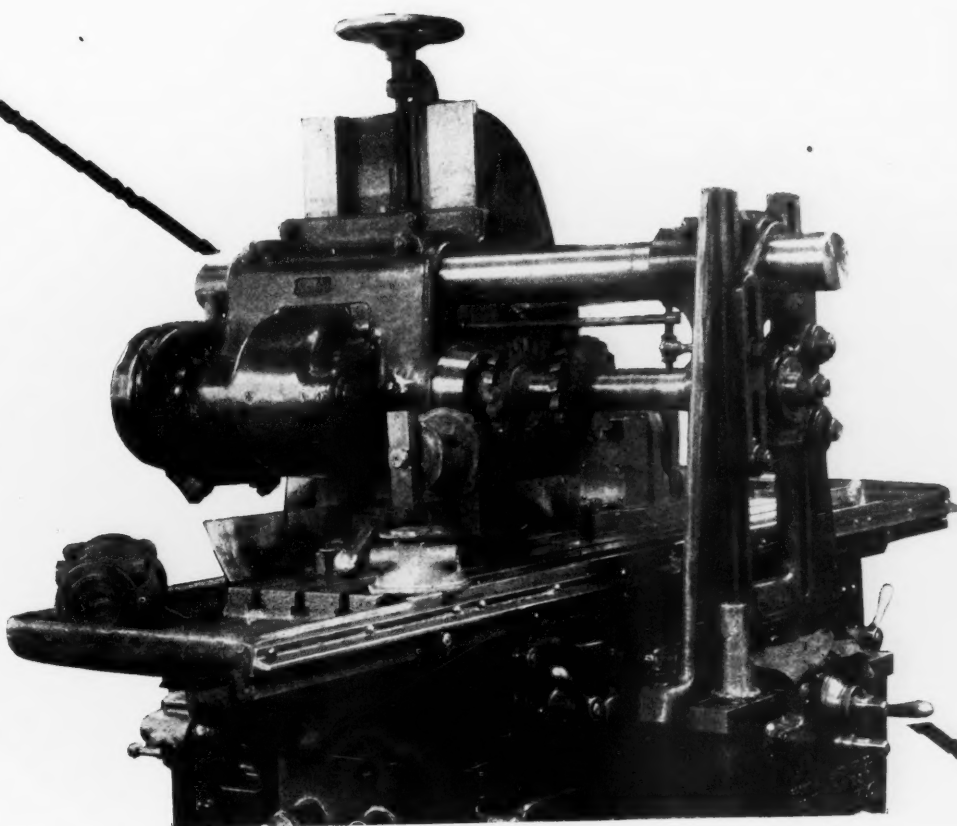
Remember that the Brown & Sharpe No. 21 Automatic Milling Machine has all the automatic features of the No. 33 and is recommended for lighter production milling.

# BROWN &

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**MODERN MACHINES THAT CUT COSTS**


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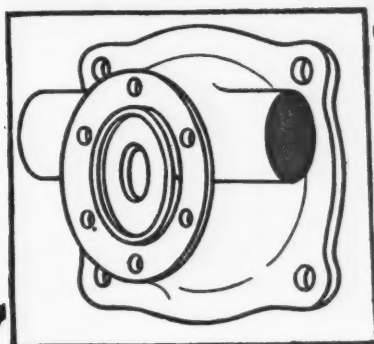
omatically" Increase Your Profits  
 on that "lower cost" job

time was saved by using a comparatively simple attachment in milling a series of bosses in an "out-of-the-way" place. Advantage is taken of the automatic intermittent feeding and the fast table return, resulting in greatly increased production.

Such operations are but typical of the adaptability of the machine to the automotive industries. It is a standard high production machine which readily lends itself to special attachments and single operation work. It is a machine which will help to increase your profits.

Send for "Brown & Sharpe Automatic Milling Machines" a well-illustrated booklet describing completely the Nos. 21 and 33 Automatic Milling Machines.

Co., Providence, R. I., U. S. A.




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**SHARPE**


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### GARDNER 10-INCH DOUBLE-SPINDLE DISK GRINDER

With a view to providing a small sized machine suitable for handling small light parts to be ground with opposite sides parallel, the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis., has brought out a 10-inch double-spindle disk grinder known as the Gardner No. 77 machine. A considerable saving is effected in power, abrasive disk expense, floor space, and initial investment, by the use of this smaller machine for parts for which it is adapted, as compared with the machine carrying an 18- or 20-inch disk wheel. The new machine is adapted for grinding parts from 1/2 inch to 1 1/2 inches in diameter and from 3/32 inch to 3 inches in thickness or length. The work may be presented to the grinding disk by hand or automatically.

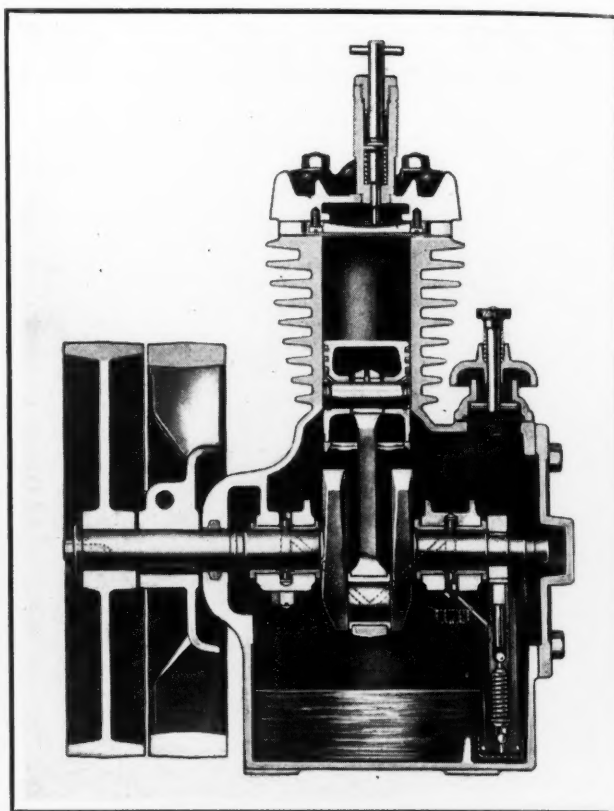
The machine is built either in the bench or floor type, the latter being illustrated herewith, and may be furnished either with belt or motor drive. The floor type machine is particularly designed for motor drive, two motors being mounted inside the base and individually belted to the machine spindles. Individual belt tighteners are provided. The motors are carefully housed and protected and ventilated through openings in the base covered with fine-meshed screens.

The grinding members consist of 8-inch diameter disk wheels faced with heavy type Gardner G.I.A. disks or of 8- by 1- by 6-inch abrasive ring wheels, carried in shallow type chucks of the straight-back type. The grinding-heads are mounted on dovetail slides fully protected from dust and dirt. The movement of the heads is actuated by a hand-lever which gives a leverage ratio of 12 to 1. Micrometer adjustment is provided for accurate setting to size.

The hinged hood is an integral part of the machine, and the dressing device is carried on its top. It is operated through a rack and pinion by means of a large handwheel, and is always in position for use. The floor type machine weighs 1225 pounds, and the bench type, 650 pounds.



Gardner 10-inch Double-spindle Disk Grinder



Worthington Vertical Air Compressor equipped with a "Feather" Valve

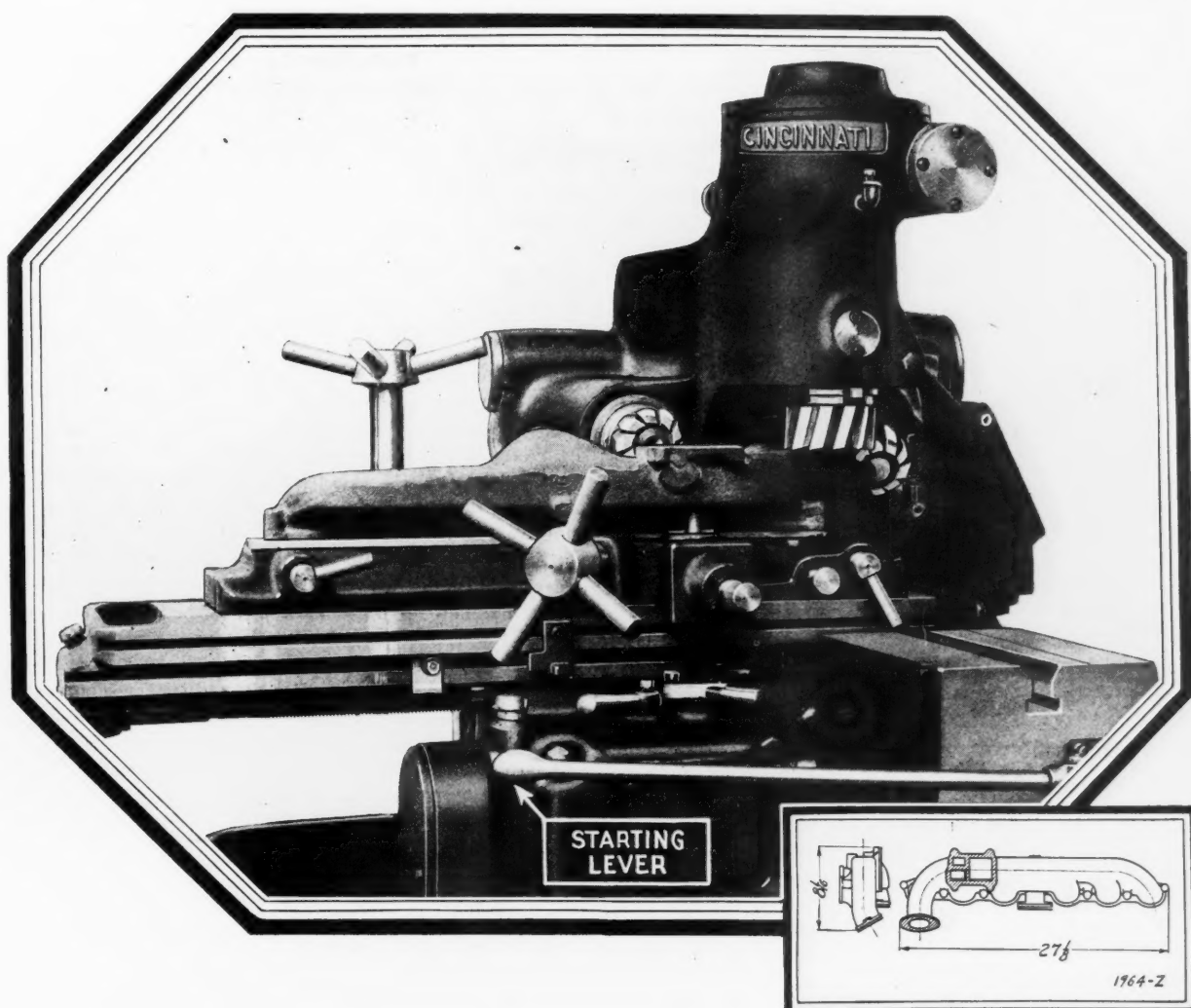
### WORTHINGTON VERTICAL AIR COMPRESSORS

A line of vertical "feather-valve" air compressors has been brought out by the Worthington Pump & Machinery Corporation, 115 Broadway, New York City, for use in small industrial plants, service stations, and garages. The compressors are made in two types, which are air- and water-cooled, respectively. The air-cooled type is made in 2 1/2- by 3-inch and 3 1/2- by 4-inch sizes, and the water-cooled type, in four sizes, of which the 6 1/2- by 5-inch is the largest. The air-cooled type is intended primarily for use in inflating tires, but the water-cooled compressors may also be used for driving hoists, drills, hammers, and other tools; painting automobiles by the spraying process; and many other purposes.

The "feather valve" is simple in construction and of light weight. The valve proper consists of a strip of ribbon steel which, when closed, covers a slightly smaller slot in the ground face seat. The strip is held but not rigidly secured at the ends by a curved drop-forged steel guard which allows the passage of air on either side of the strip. The suction and discharge valves and guards are identical and interchangeable. The piston is of the automobile type, ground to size and fitted with three hammered piston-rings. Forced-feed lubrication is provided for all bearings. Provision is made for wiping surplus oil off the walls and returning it to the crankcase, which is said to keep the compressed air remarkably free from oil.

### UNION MOTOR-DRIVEN HOLLOW CHISEL MORTISER

Gallmeyer & Livingston Co., 344 Straight Ave., S. W., Grand Rapids, Mich., has brought out the hollow chisel mortiser shown in the accompanying illustration. This machine may readily be converted into a plain vertical boring machine by removing the chisel holder. A 1/2-horsepower motor, regularly furnished, provides sufficient power for chisels up to 1/2 inch in diameter. If desired, a one-horsepower motor may be used to increase the chisel capacity.



## THREE HEADS are better than one—or even two

### Pyramid Column Millers

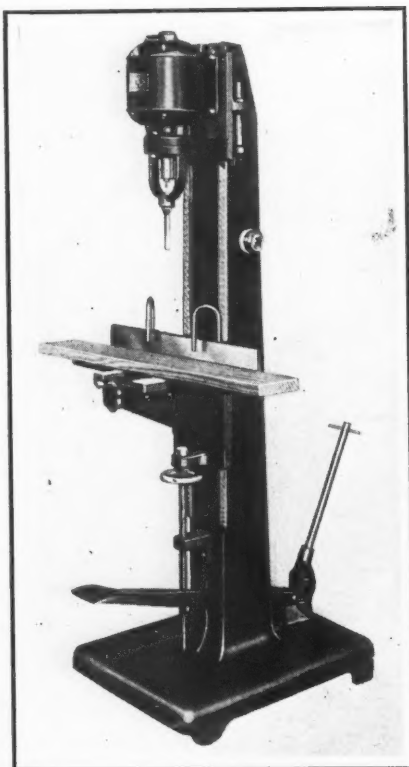
Have you seen  
the new Cin-  
cinnati Millers  
—knee and col-  
umn type? Send  
for new bulle-  
tins just issued.

CINCINNATI  
MAKES MORE MACHINE  
TOOLS IN LARGER VARI-  
ETY THAN ANY OTHER  
FIRM IN THE WORLD  
TO SEE ANY UP-TO-DATE  
MACHINE TOOL COME TO  
CINCINNATI

Here we have modified a standard 24" Automatic Cincinnati Miller to mill cast-iron manifolds. Three plain surfaces are milled simultaneously avoiding the accumulation of parts between operations and insuring that the surfaces bear proper relation to each other. A three-spindle milling head on a standard machine satisfies these requirements. Production about 30 pieces per hour. This is but one of hundreds of cases where our Engineering Service Department has been able to cooperate with the manufacturer in lowering costs and increasing production. Whether your job requires a knee and column type miller or an automatic fixed bed type machine we have the right machine for your job. Use our "Service that Saves."

THE CINCINNATI MILLING MACHINE COMPANY  
CINCINNATI, OHIO

# CINCINNATI MILLERS



Union Hollow Chisel Mortiser

chisel holder or replacing it in accurate alignment. The motor head has a vertical travel of 3 3/4 inches, controlled by a foot-treadle with a flexible tension spring providing the return movement. A truck type of base makes the machine portable, but when the handle at the rear is thrown against the column the machine rests solidly on the floor. The regular equipment includes ball-bearing motor, extension cord, socket, switch, and 3/8-inch hollow chisel and bit.

### BOILER WELDING EQUIPMENT

The latest addition to the line of automatic arc welding machinery built by the General Electric Co., Schenectady, N. Y., is equipment especially designed for the construction of range boilers and small tanks. This equipment includes two separate automatic arc welding machines, one for welding longitudinal seams and the other for circular seams. Tanks from 11 to 33 inches in diameter and up to 6 feet in length can be handled by this equipment. The equipment for both longitudinal and circular seam welding is made up of the same standard units as are used with other automatic arc welding equipment, with the exception of the framework for holding the tanks, which is especially adapted to the work in question. A pneumatic clamping device operated by a small lever grips and releases the work automatically. Both machines are arranged for push-button control within easy reach of the operator. The machine for circular welding revolves the work automatically while ends are welded.

### ERIE BOARD DROP-HAMMER

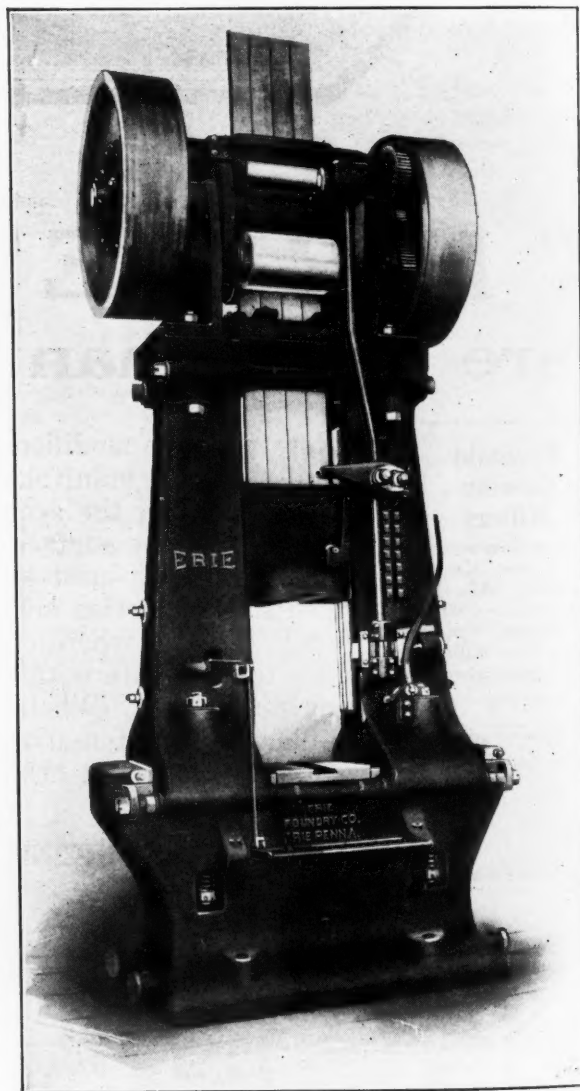
The latest addition to the line of forge shop equipment built by the Erie Foundry Co., Erie, Pa., consists of the four-roll board drop-hammer here illustrated. Two sets of rolls are provided on this machine with a view to reducing the unit pressure on the board when lifting the ram, and thus lengthening the life of the boards. The head is symmetrical front and back, the only difference being that the front eccentric, actuated by the friction bar, operates at each stroke of the hammer, while the back eccentric is adjustable to accommodate boards of varying thicknesses. The upright side housings of the head are supported by a cast-steel tie-plate which also carries the floating head or clamp. Journaled in

the uprights of the head are the cast-steel eccentrics, each of which carries two equalizers that are free to turn about the eccentrics. As the eccentrics are rotated, the equalizers are forced toward the hammer board.

The tops of each pair of equalizers are fastened together by means of cast-steel bars, so that each pair of equalizers must always work as a unit, with the ends in line with each other. The rolls are mounted on shafts which are carried in bores in the ends of the equalizers, one roll being at the top and one at the bottom of each pair of equalizers. The pressure put on the board by the rolls will always be equally divided between the top and bottom pairs of rolls, regardless of whether or not the front and back of the board are parallel. This point is of particular importance, since a low spot is frequently worn at one point of the board or the board may wear taper.

One considerable source of expense in operating board drop-hammers is the maintenance of the belt, due to its high working tension. In this four-roll hammer, a gear reduction has been interposed between the pulley shaft and the roll shaft to make the former run at twice the number of revolutions per minute that the latter runs at. This permits a decrease in the cross-sectional area of the belt.

The hammer is built with a box-section frame, and is equipped with novel guides for the ram. On the upper half of the frame, there is a single V-guide cast integral with the frame. The bottom half of the guide is a separate piece held in a pocket in the frame. The guides are interchangeable from one frame to another, and can be turned end for end. In the 5000-pound hammer, the renewable part of the guides has three vees, to provide ample bearing area.



Erie Four-roll Drop-hammer

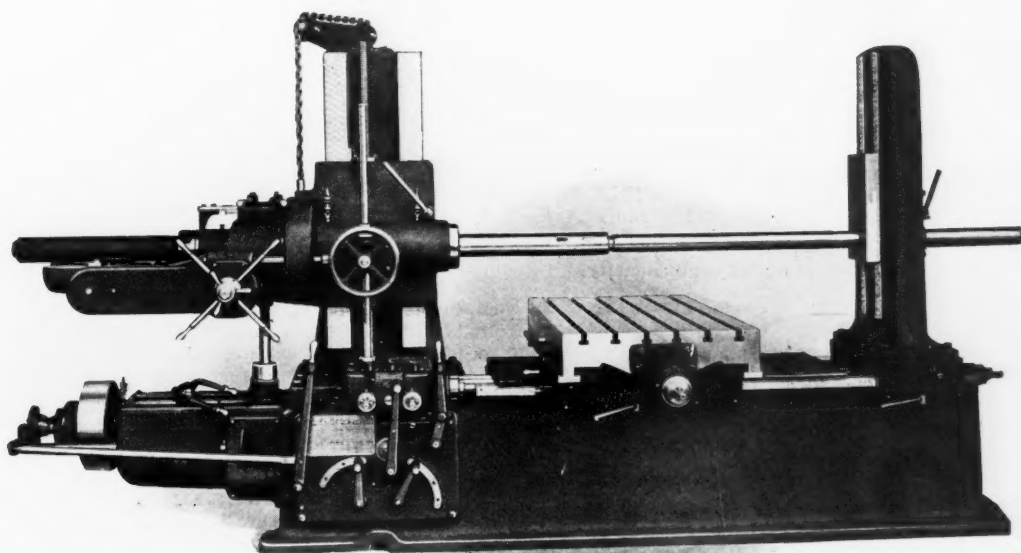
Pre-eminent in the toolrooms and experimental departments of

## AUTOMOTIVE PLANTS

The LUCAS

# "PRECISION"

Horizontal Boring, Drilling and  
MILLING MACHINE



We also make the  
**LUCAS Power Forcing Press**

For straightening ring gears, axle forgings, etc., and  
assembling parts under pressure.

**THE LUCAS MACHINE TOOL CO.**



**CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Oslo, Stockholm. R. S. Sokvis & Zonen, Paris and Rotterdam, Andrews & George Co., Tokyo.

## WATSON-STILLMAN HYDRO-PNEUMATIC PRESS

A two-rod hydro-pneumatic press designed for operations involving forcing, pressing, and bending, has been placed on the market by the Watson-Stillman Co., 192 Fulton St., New York City. The machine is intended particularly for

railroad shops and other large shops. It provides a means of rapidly pressing bushings or driving-box brasses in or out and gears on or off shafts. Because of its long platen or base, it can be used for many bending and straightening operations.

The ram movement is from the top downward, and is actuated by hydro-pneumatic force obtained from an air-engine pump which is intended for connection to the air line of the shop. The valve control is simple and easily operated, and is provided with a gage which

Watson-Stillman Two-rod Hydro-pneumatic Press

registers, in tons, the pressure exerted by the ram. A jib crane is provided as part of the press to facilitate handling the work. The press illustrated is of 100 tons capacity.

## SYRACUSE BELT GRINDER AND SANDER

Another combined horizontal and vertical belt grinder and sander has just been placed on the market by the Porter-

Cable Machine Co., North Salina and Exchange Sts., Syracuse, N. Y. This machine, designated as type B3, is equipped with a grinding bed measuring 10 1/2 by 23 inches, and an abrasive belt 10 inches wide by 71 inches long. It may be used for putting a straight grain finish on metal, wood, fiber, bone, celluloid, bakelite and other materials.

The bed may be changed from the vertical to the horizontal position, or vice versa, by removing four cap-screws which are easily accessible. A 150-pound weight on the end of the

frame, when the table is in the horizontal position, prevents an unbolted machine from tipping over. The table tilts 15 degrees up and 45 degrees down. The dust chute is fastened to the base to do away with the necessity of removing it when belts are to be changed or the table is to be tilted. The upper dust guard is attached by means of thumb-screws so that it can be easily removed. Power is provided by a motor which drives the pulley through a coupling. The belt speed of this machine is 3300 feet per minute, and the weight, about 375 pounds.

\* \* \*

## PERSONALS

GUY HUBBARD, who for ten years has been actively associated with the machine tool industry, is now on the staff of the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

W. C. DAVIS, president of the Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill., has recently been appointed a member of the Committee on Commercial Gear Standards of the American Gear Manufacturers' Association.

J. HAROLD KRAUS, JR., has been placed in charge of the Detroit office of the Bantam Ball Bearing Co., Bantam, Conn. The Detroit office is located at 3780 Chicago Boulevard. Mr. Kraus will handle the entire Michigan territory, as well as Toledo.

L. M. ZIMMER has been appointed general sales manager of the Linde Air Products Co., 30 E. 42nd St., New York City (manufacturer of oxygen, nitrogen and air products) and of the welding gas division of the Prest-O-Lite Co., Inc., (manufacturer of dissolved acetylene). Mr. Zimmer has been assistant general sales manager since 1924, and succeeds L. M. MOYER as general sales manager.

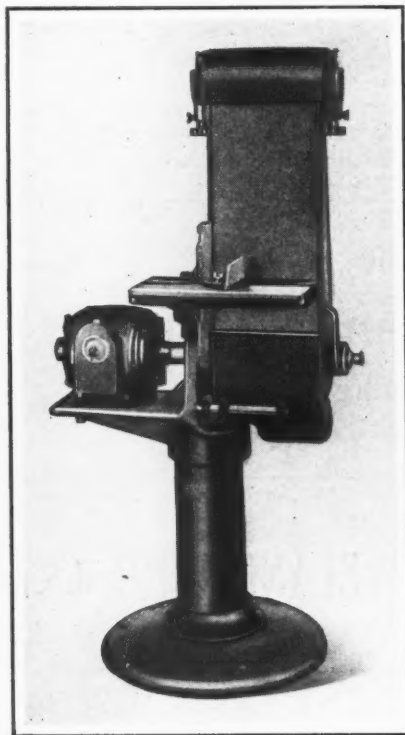
FRANKLIN FROTHINGHAM has joined the sales organization of the Chicago Belting Co. as New England manager in charge of the sales of all the Chicago belting products in Massachusetts, Maine, New Hampshire, Vermont, Rhode Island, and part of Connecticut. Mr. Frothingham's headquarters will be at the Boston branch, which has been moved to 179 Lincoln St., Albany Building, Boston, Mass.

ROBERT J. ANDERSON, aluminum expert and metallurgical engineer, will be presented with the William H. McFadden gold medal by the American Foundrymen's Association in recognition of his achievements in the non-ferrous casting industry and of his many scientific contributions to the metallurgy of aluminum. The formal award of the medal will be made on October 9 at Syracuse, N. Y., in connection with the fall meeting of the association.

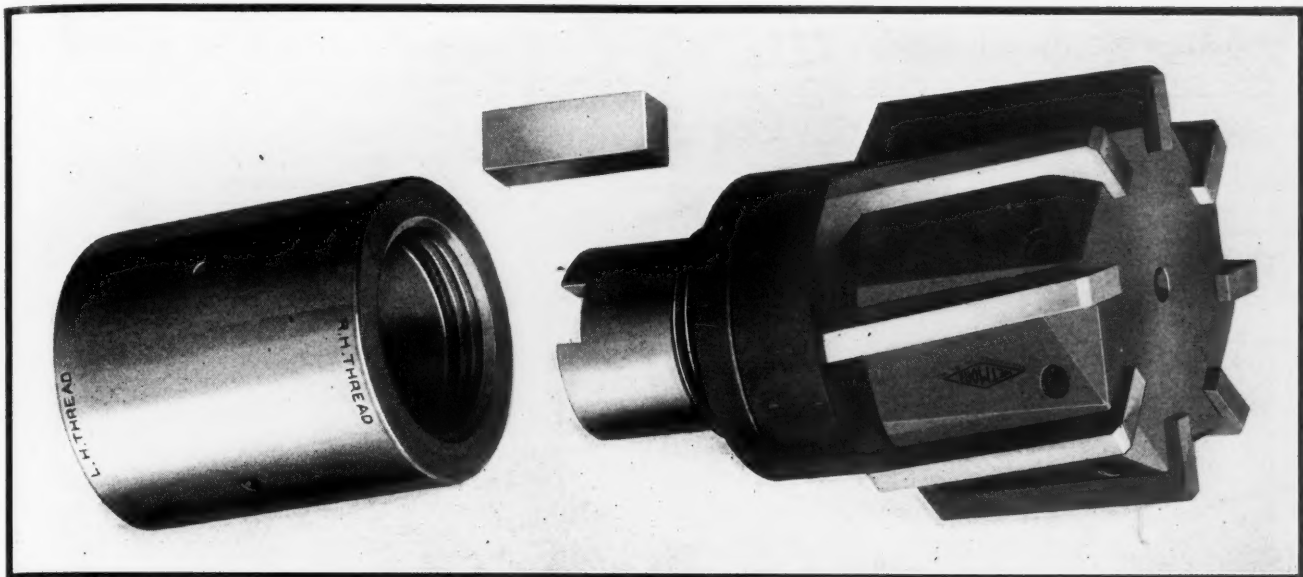
W. MCNAMEE, formerly purchasing agent for the Holt Mfg. Co., Peoria, Ill., has recently joined the sales organization of the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill. Mr. McNamee has been appointed district representative of the state of Indiana and all of Illinois except that section lying west and south of Springfield, which is handled from the St. Louis Office. The territory within a radius of thirty miles of Chicago in both Indiana and Illinois is taken care of from the home office.

R. W. WOODWARD has resigned as chief metallurgist of the Whitney Mfg. Co., Hartford, Conn., to become associated with the Stanley P. Rockwell Co., consulting metallurgical engineers of Hartford, Conn. The latter company is now placing on the market the Rockwell Dilatometer, an equipment for the precise heat-treatment of steel, and Dr. Woodward will have charge of this department of the company, as well as being available for general consulting practice. Dr. Woodward was formerly chief of the section of mechanical metallurgy of the United States Bureau of Standards, and has had a wide experience in the metallurgy of both ferrous and non-ferrous metals.

S. HORACE DISSTON, vice-president in charge of sales, of Henry Disston & Sons, Inc., Philadelphia, Pa., addressed the Purchasing Agents' Association of Pittsburg at its regular meeting and dinner September 15, and exhibited a three-reel motion picture showing how Disston saws, tools, and files are made. The film showed the various operations from the pouring of the special steels used in the manufacture of Disston saws and files to the polishing and inspecting of the finished products, and concluded with a passing in review on the screen of the different tools made by this company, ranging from the finest jeweler's files and delicate surgical saws to the huge bands and disks of steel that slice the red-woods of the Pacific coast.



Syracuse Belt Grinder and Sander



### The Bull-Dog

Famous Wetmore Heavy-Duty Expanding Reamer  
1" to 2 15/16"....6 blades  
3" to 4 1/2".....8 blades

## How This "Wetmore Bull-Dog" Cuts Production Costs

THIS Wetmore "Bull-Dog" Reamer combines all the advantages of both solid and adjustable reamers. Key drive relieves strain on coupling nut, or reamer can be furnished with arbor integral. Large adjustment provides for wear and regrinding, so that this reamer with its original blades actually outlasts several solid, non-adjustable reamers. The 1/8" projection of the blades over the end of the reamer body allows the chips to fall off ahead of the reamer and prevents chips from clogging up along cutting edge of blades.

Wetmore Expanding Reamers are being specified in many of the largest shops because they *cut production costs*, (1) by doing faster, more accurate work; (2) by their longer life. Here are a few Wetmore features that appeal to production men:

The method of holding the blades in the Wetmore Heavy-duty Reamer eliminates unnecessary extra parts. This saves time and simplifies the replacement and adjustment of blades.

All Wetmore blades are scientifically ground for working various metals—steel, cast iron, bronze, etc. Best high-speed steel, ground to thickness, length and on seat. Tested for hardness and toughness. In ordering, give type and size of reamer and whether reamer is to be used on steel, cast iron or bronze.

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made.

Cone expansion nut keeps blades always parallel with axis.

Solid, alloy steel body, heat treated, guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring of the reamer while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.



### FREE CATALOG

Write today for Wetmore catalog, showing complete line of standard, heavy-duty, shell, small machine and cylinder reamers. Also arbors and replacement blades. Sent free—postpaid.

**WETMORE REAMER COMPANY**

MILWAUKEE

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**WETMORE** **EXPANDING REAMERS**  
"THE BETTER REAMER"

## OBITUARIES

## B. M. W. HANSON

Bengt M. W. Hanson, president of the Hanson-Whitney Machine Co., Hartford, Conn., and one of the best known inventors and designers in the machine tool field, died at his home in Hartford, Conn., Sunday afternoon, September 6. He had been in failing health for a number of years, but was seriously ill only for about a week previous to his death.

Mr. Hanson was born in Sweden in 1866, the son of Major Magnus Hanson. He came to America in 1890, and was first employed by the Waltham Watch Co., where his mechanical ability soon became recognized. Five years later he went to the Pratt & Whitney Co., Hartford, Conn., working first at the bench in the small tool department as a mechanical expert, and steadily advancing through various executive positions until he became works manager and vice-president of the company. During this period he was responsible for the design of numerous



machines placed on the market by the Pratt & Whitney Co., and scores of patents were taken out by him. He was responsible for the development of the special rifle-making equipment that the Pratt & Whitney Co. furnished to a number of arsenals all over the world immediately before and during the early part of the war.

In 1915, Mr. Hanson was appointed a civilian member of the Machine Gun Board of the War Department. Shortly afterward he left the Pratt & Whitney Co. and became vice-president and general manager of the Colt Patent Fire Arms Mfg. Co., where he had charge of gun production during the critical stage of the World War. In 1918 he left the Colt Co. and opened an engineering bureau in Hartford, later—in 1920—organizing the Hanson-Whitney Machine Co., of which he became president. Associated with him was Clarence E. Whitney, president of the Whitney Mfg. Co. Among the best known developments in the mechanical field of recent years that are due largely to Mr. Hanson's efforts are ground thread taps, and measuring tools and gages of various descriptions.

Mr. Hanson was a director of the Skayef Ball Bearing Co., a member of the American Society of Mechanical Engineers, a former president of the Manufacturers' Association of Hartford County, and a member of the Hartford Chamber of Commerce and the Connecticut Chamber of Commerce. He is survived by his wife; a son, Einar A. Hanson, who is connected with the Hanson-Whitney Machine Co.; and a daughter.

In commenting upon Mr. Hanson's death, Clarence E. Whitney, his partner and business associate, stated: "The world has lost one of its most brilliant mechanical engineers. Our country has lost one of its most patriotic citizens. I believe that but few realize the magnitude of his contribution toward the winning of the World War."

ROBERT J. LYND, president of the Lynd-Farquhar Co., Boston, Mass., died on August 31, at his home in Newton Highlands, Mass. Mr. Lynd's first connection with the machine tool industry was as salesman for the A. B. Pitkin Machinery Co., of Boston. He later became associated with the Chandler & Farquhar Co., and in 1904 was admitted to the firm and elected vice-president. In 1917 the Lynd-Farquhar Co. was organized, with Mr. Lynd as president.

EDWARD P. SELDEN, formerly president of the Erie City Iron Works, and for fifty years connected with that concern, died in Erie, Pa., on September 11. Mr. Selden was one of the pioneers in manufacturing some of the improved types of boilers now in use and was well known in the steel trade.

## TRADE NOTES

E. W. BLISS Co., 53rd St. and Second Ave., Brooklyn, N. Y., has moved its Detroit office from the Dime Bank Building to the General Motors Building, Detroit, Mich.

GENERAL ELECTRIC Co., Schenectady, N. Y. has made plans for the immediate erection of a large warehouse and office building at Santa Fe Ave. and 52nd St., Los Angeles, Cal. The plant will be used as a distributing center.

INDEPENDENT PNEUMATIC TOOL Co., 600 W. Jackson Blvd., Chicago, Ill., manufacturer of "Thor" pneumatic and electric tools, has opened a branch office at 288 E. Water St., Milwaukee, Wis. G. H. DuSelle will be in charge of the Milwaukee branch.

ABRASIVE Co., Bridesburg, Philadelphia, Pa., manufacturer of grinding wheels and polishing grain, took possession during September of its enlarged office building adjoining the main plant at Bridesburg. The new quarters give double the old space for office purposes.

CAREY MACHINE Co., Cleveland, Ohio, formerly located on Curtis Ave., has now moved into a new plant at 9518 Cassius Ave. The new plant is 90 by 120 feet and is fully equipped for contract machine work and special machinery building. U. P. DeHart is president and general manager, and A. T. Merrell, superintendent.

CINCINNATI ELECTRICAL TOOL Co., 1519 Freeman Ave., Cincinnati, Ohio, manufacturer of portable electric drills, grinders and buffers, at a reorganization meeting of the board of directors, elected the following officers: President and treasurer, Joseph Wolf; vice-president, R. K. LeBlond; and secretary, Edward G. Schultz. The company expects to move into larger quarters soon and to expand its business in a general way.

MONITOR CONTROLLER Co., Baltimore, Md., manufacturer of automatic motor starters and control apparatus and "Edge-wound" resistors, has established a branch office in Washington, D. C., in the Evening Star Building, at 11th St. and Pennsylvania Ave. C. R. Speaker will be in charge of the new office and of the territory embracing the district of Columbia, state of Virginia, and the southern part of the state of West Virginia.

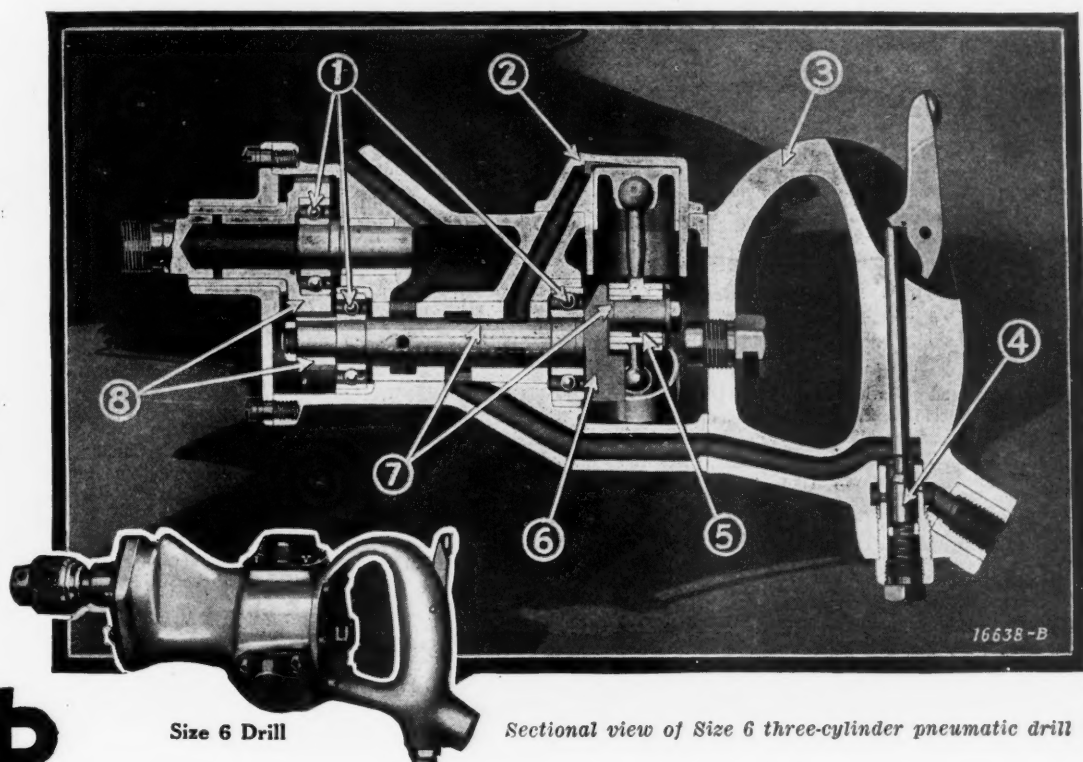
HERMANN ASSOCIATES, INC., has been organized, with main offices at 610 Best Building, Rock Island, Ill. The corporation has for its purpose the conduct of a general mechanical, automotive, industrial, and agricultural engineering business. The firm has under manufacture at the present time a new type of carburetor. The officers of the corporation are: C. C. Hermann, president; W. F. Meiburg, vice-president; J. F. Hermann, secretary; and H. E. Hermann, treasurer.

LINCOLN ELECTRIC Co., Cleveland, Ohio, manufacturer of the "Stable-arc" welder, is planning to extend the training course in welding which it has been conducting for the last two years in cooperation with the Cleveland School of Technology. The plan provides for alternating five-week training courses, by which half of the students' time is spent in the manufacturing plant and the remainder in school. The students, during the time they work in the factory, are paid the same as full-time employees.

STROM BALL BEARING MFG. Co. announces that the plant, property and good will of the company have been acquired by the MARLIN-ROCKWELL CORPORATION. The business of the company will be conducted the same as heretofore, and there will be no change in the personnel or policy of the company. The present line of bearings made under the "Strom" trade name will be continued. All correspondence should be addressed to the Marlin-Rockwell Corporation, successor to Strom Ball Bearing Mfg. Co., 4535 Palmer St., Chicago, Ill.

EX-CELL-O TOOL & MFG. Co., 1469 E. Grand Blvd., Detroit, Mich., has appointed the following representatives during the last few months: E. D. Bishop Co., Perry Payne Bldg., Cleveland, Ohio; A. E. Coburn, 12 Sterrett Place, Crafton, Pittsburg, Pa.; James O. Coleman, 831 N. Eighth St., St. Louis, Mo.; Albert T. Fisher, 500 Bell Block, Cincinnati, Ohio; R. W. Hansen, 4742 Kenmore Ave., Apt. 39, Chicago, Ill.; Kemp Machinery Co., 215 N. Calvert St., Baltimore, Md.; A. V. Wiggins Co., 384 W. Fayette St., Syracuse, N. Y.; W. A. Laub Co., Franklin Trust Bldg., Philadelphia, Pa.; Oscar H. Lorange, 830 Old South Bldg., Boston 9, Mass.; Ivan M. Lytle Co., 1305 Sutter Ave., San Francisco, Cal.; J. W. Mull, Jr., 412 Board of Trade Bldg., Indianapolis, Ind.; Walter Phillips, Autocar Auxiliaries, Ltd., Letchworth Herts, England; Triplex Machine Tool Co., 50 Church St., New York City.

# I-R 3-Cylinder Pneumatic Drills



Size 6 Drill

Sectional view of Size 6 three-cylinder pneumatic drill

*Lightweight machines that have increased production for dozens of shops*

Ingersoll-Rand Three-Cylinder Pneumatic Drills avoid interruptions due to break-downs; are free from vibration; have high power with light weight and low air consumption. They have few parts, and the maintenance costs are low. The following reasons tell why:

1—Crank shaft, valve and spindle are supported on ball bearings. Valve floats in valve bushing, which avoids wear on bushing.

2—A three-cylinder motor is used. Each of the three cylinders is a part separate from the body of the machine. Each cylinder is of cast iron and is renewable and interchangeable. The case of the machine is of aluminum to give light weight.

3—Handle, of light weight aluminum, can be removed by taking out six cap screws. Crank chamber is then open for inspection.

4—Combination poppet and piston type throttle valve gives exact control and avoids air leakage.

5—Solid end connecting rods—no hinges, bolts nor screws. Connecting rods held to crank pin by solid rings.

6—Crank shaft accurately counterbalanced, which eliminates vibration and wear. There is no vibration to cause breakage of 3/16-in. or 1/4-in. drills.

7—Valve and crank made in one piece. This avoids extra valve parts, gears, rockers, or eccentrics.

8—Gearing of high efficiency and low weight. This type is made in six sizes and can be furnished with either grip handle, breast plate or screw feed.

INGERSOLL-RAND COMPANY -- 11 BROADWAY, NEW YORK CITY.

*Offices in principal cities the world over.*

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## COMING EVENTS

OCTOBER 5-9—Annual convention of the American Foundrymen's Association at Syracuse, N. Y. An exhibition of foundry and machine shop equipment and supplies will be held in connection with the convention.

OCTOBER 21-23—Fall meeting and exhibit of the American Welding Society at the Massachusetts Institute of Technology, Cambridge, Mass. M. M. Kelly, 33 W. 39th St., New York City, secretary.

NOVEMBER 30—DECEMBER 4—Annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, 29 W. 39th St., New York City. Calvin W. Rice, secretary.

NOVEMBER 30—DECEMBER 5—Fourth national exposition of power and mechanical engineering to be held in the Grand Central Palace, New York City.

JANUARY 11-13—Second World Motor Transport Congress to be held in New York City during the National Automobile Show. Sponsored by the National Automobile Chamber of Commerce, 366 Madison Ave., New York City.

## NEW BOOKS AND PAMPHLETS

MICHIGAN COLLEGE OF MINES. Houghton, Mich. Year book for 1924-1925, containing announcement of courses and calendar for 1925-1926.

A STUDY OF REINFORCED CONCRETE DAMS. By Elmo G. Harris. 56 pages, 6 by 9 inches. Published by the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo.

UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR RUBBER GOODS (Methods of Physical Tests and Chemical Analyses). 42 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 232 of the Bureau of Standards.

COMPARATIVE SLOW BEND AND IMPACT NOTCHED BAR TESTS ON SOME METALS. By S. N. Petrenko. 32 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 289 of the Bureau of Standards.

PROCEEDINGS OF THE NATIONAL ASSOCIATION OF OFFICE MANAGERS, SIXTH ANNUAL CONFERENCE. 113 pages, 8½ by 11 inches. Published by the National Association of Office Managers; F. L. Rowland, secretary, care of the Lincoln National Life Insurance Co., Fort Wayne, Ind. Price, \$2.

DIRECTORY OF IRON AND STEEL PLANTS AND ALLIED INDUSTRIES FOR 1925. 358 pages, 6 by 9 inches. Published by the Andresen Co., Inc., 108 Smithfield St., Pittsburgh, Pa.

This directory contains a list of companies and officials operating blast furnaces, steel plants, rolling mills, by-product coking plants, structural steel, boiler and tanks, railroad shops, forging, heat-treating and stamping plants in the United States and Canada. A new feature of the present edition is the list of the larger railroad shops, which has been added because of the fact that they are large consumers of steel and iron and use a large amount of equipment similar to that of other steel-working plants. Besides the alphabetical list, there is a geographical index of companies and plants.

THE GASOLINE AUTOMOBILE. By P. M. Heldt. 378 pages, 5½ by 8¼ inches. Published by P. M. Heldt, Nyack, N. Y. Price, \$5.

This is the fourth and final volume of a work on the design and construction of the gasoline

automobile, the subjects treated in the present volume being fuels and carburetors. The fuel system, including the fuel tank with its appurtenances, the fuel strainer and piping, the fuel feed system, the carburetor, and the air cleaner are dealt with in detail. A discussion of the available motor fuels is included, covering sources, methods of production, chemical and physical properties, their requirements with respect to carburetor design, and the results obtained with them experimentally or in regular service. Ten chapters are devoted to the carburetor, starting with early types and carrying through the developments of this important device to the present improved design.

## NEW CATALOGUES AND CIRCULARS

CAPACITORS. General Electric Co., Schenectady, N. Y. Bulletin GEA-77, descriptive of "Capacitors" for power-factor correction on electric generating and distributing systems.

PORTABLE ELEVATORS. New Jersey Foundry & Machine Co., 90 West St., New York City. Circular illustrating and describing some new designs of portable freight elevators.

STAINLESS STEEL AND IRON. American Stainless Steel Co., Commonwealth Bldg., Pittsburgh, Pa. Circular containing a list of some of the many applications of stainless steel and iron.

COUPLINGS. Farrel Foundry & Machine Co., Buffalo, N. Y. Folder C, illustrating and describing the Sykes universal shaft coupling, which is designed to compensate for all kinds of misalignment between connecting shafts.

PIPE THREADING MACHINERY. Landis Machine Co., Waynesboro, Pa. Catalogue 29, illustrating and describing in detail the Landis line of pipe threading and cutting machines, pipe and nipple threading machines, and chaser grinders.

POWER RAPID TRAVERSE FOR MILLING MACHINES. Kearney & Trecker Corporation, Milwaukee, Wis. Circular announcing the fact that all Kearney & Trecker milling machines now include power rapid traverse and a newly designed friction clutch as standard equipment.

MILLING CUTTERS. Goddard & Goddard Co., Detroit, Mich. Railroad Catalogue No. 1, containing data covering special and standard milling cutters designed and manufactured especially for use in railroad shops. Considerable information is included on the use of these cutters.

TRUCKS AND TRACTORS. Crescent Truck Co., Lebanon, Pa. Catalogue describing the complete line of electric industrial trucks, tractors, and trailers made by this company. Specifications are given for the different types of trucks, and a wide variety of applications is illustrated.

BLUEPRINTING EQUIPMENT. Paragon Machine Co., Rochester, N. Y. Catalogue describing, first, the method employed in making blueprints with Paragon equipment, and second, Paragon continuous electric blueprinting machines. The various sizes and types of machines are illustrated.

ARC WELDING. Lincoln Electric Co., Cleveland, Ohio. Bulletin descriptive of electric arc welding, with particular reference to the use of the "Stable-arc" welder, which is built for both alternating and direct current, and may be applied for general welding in manufacturing.

GEARED-HEAD LATHES. Cincinnati Lathe & Tool Co., 3207 North St., Oakley, Cincinnati, Ohio. Leaflet illustrating and describing Cincinnati 16- to 30-inch geared-head engine lathes, equipped with either single-pulley belt or motor drive. The various details of construction are completely described.

RECORDING PRESSURE AND VACUUM GAGES. Brown Instrument Co., 4532 Wayne Ave., Philadelphia, Pa. Catalogue 74, illustrating and describing Brown recording pressure and vacuum gages. The booklet reproduces some typical charts made with these gages, and describes their application and operation.

TURRET LATHES. Foster Machine Co., Elkhart, Ind., is distributing blueprints and photographs showing actual production figures and savings effected in machining bearing housing caps for farm tractors on the Foster 1-B turret lathe provided with Foster-Barker wrenchless chuck and complete tooling equipment.

CRANES AND FOUNDRY EQUIPMENT. Whiting Corporation, Harvey, Ill. General catalogue, covering the complete line of cranes and foundry equipment made by this concern, including cranes of all types, cupolas, ladles, tumbling mills, core oven equipment, trucks, turntables, and trolley systems, air hoists and elevators, converters, and brass foundry equipment.

EQUIPMENT FOR DRAWING STEEL. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Catalog 93, descriptive of the "Homo" method for the drawing of steel. Considerable technical information is given regarding the process and the equipment employed, including the "Homo" electric drawing furnace, single-point recording potentiometer controller, and automatic control panel.

TURRET LATHES. Warner & Swasey Co., Cleveland, Ohio. Booklet entitled "Net Profits from Small Lots," showing a number of jobs performed on Warner & Swasey universal turret lathes provided with standard tool equipment. The illustrations are taken from the plants of customers and show comparative facts about keeping the machine busy, set-up time, production, and net profits on the investment.

CONTINUOUS MILLING MACHINES. Ingersoll Milling Machine Co., 2442 Douglas St., Rockford, Ill. Circular showing examples of continuous milling machines developed largely to meet conditions in the automotive industry. Some examples are also shown of single-purpose machines designed to be used where the amount of production involved or the character of the surfaces to be milled makes them more economical than continuous milling machines.

SPEED REDUCERS. D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill. General catalogue 99, covering the complete line of products made by this concern, which include gears, spur gear speed reducers, worm-gear speed reducers, and couplings. The catalogue contains many pages of general engineering data, and gives information needed in designing and specifying drives of all kinds on elevating, conveying, and power transmitting, and process machinery.

HACKSAWS. Simonds Saw & Steel Co., Fitchburg, Mass., is distributing a booklet entitled "Hacksaw-ology," containing information on the care and use of hacksaw blades. The best methods for cutting different kinds of metals by power or hand are explained in non-technical terms. Directions for the proper selection of blades for various cutting operations and the use of lubricants in power operations are given. The booklet is made in vest-pocket size for ready reference.

BALL BEARINGS. Fafnir Bearing Co., New Britain, Conn. The September number of *The Dragon*, the regular monthly publication of this concern, is designated as the machine tool number, and is devoted principally to the subject of ball bearing applications for machine tools. Illustrations and descriptive material cover the application of Fafnir ball bearings in gear shapers, lathes, grinding machines of various types, automatics, milling machines, and drilling machines. Each of the applications refers to an actual installation on specific machines. Copies will be sent to those interested, upon request.